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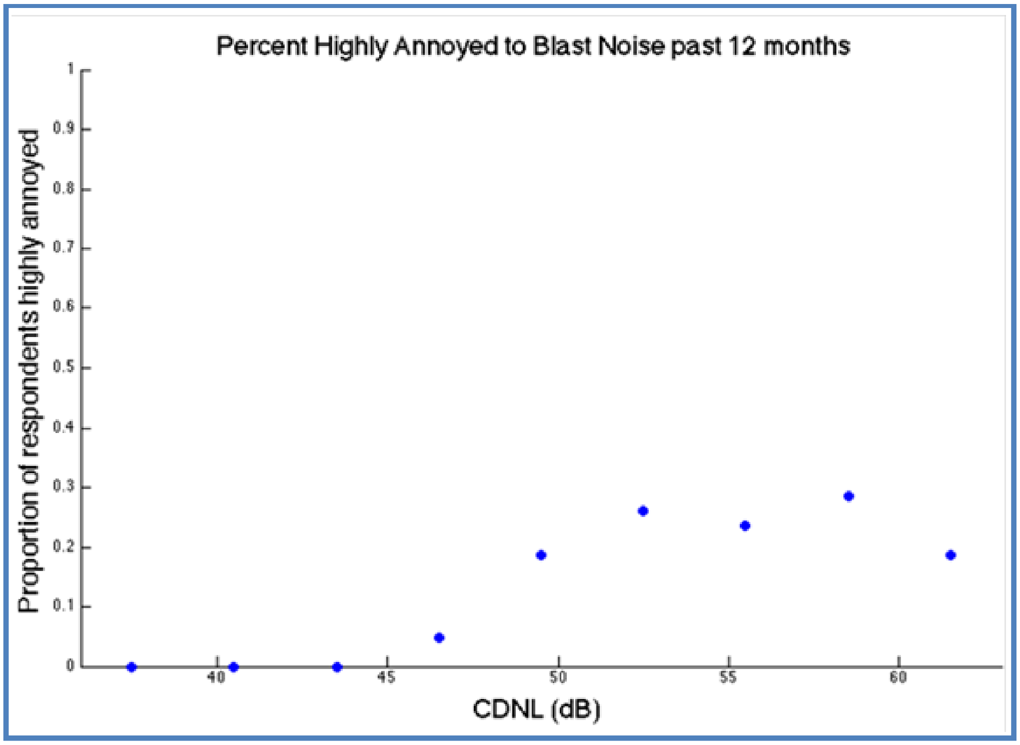
Strategic Environmental Research and Development Program (SERDP)

An Investigation of Community Attitudes Toward Blast Noise

General Community Survey, Study Site 1

Edward T. Nykaza, Dan Valente, S. Hales Swift, Brendan Danielson, Peg Krecker, Kathleen Hodgdon, and Trent Gaugler

April 2012



Construction Engineering Research Laboratory

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Abstract

Current blast noise assessment procedures at military installations in the United States do not fully meet the military's noise management needs; military blast noise sometimes disturbs surrounding communities, resulting in legal actions against US military installations. Specifically, current procedures do not accurately capture the way humans respond to blast events, and do not adequately account for the level, number, timing, and spatial variability of blast noise events. This work constructed and administered the General Community Survey (GCS) within SERDP Project WP-1546 at the first of three military installations to determine how blast noise levels affect general community annoyance and how the community reaction changes over time in response to a dynamic blast noise environment. The results indicate that, while blast noise was the most annoying noise source around this installation, current blast noise assessment metrics are weakly correlated with community annoyance, and a large percentage of the study population were highly annoyed at relatively low C-weighted Day-Night blast noise levels. Current findings highlight the importance of capturing temporal and spatial variation of the both stimulus and response, and also of non-acoustical factors such as habituation and vibration.

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Preface

This study was conducted for the Strategic Environmental Research and Development Program (SERDP), under Project WP-1546, "An Investigation of Community Attitudes Toward Blast Noise Complaint Survey Protocol" via Military Interdepartmental Purchase Request (MIPR) W74RDV20307627. The SERDP technical monitor was Bruce Sartwell, SERDP.

The work was performed by the Ecological Processes Branch (CN-N) of the Installations Division (CN), Construction Engineering Research Laboratory (ERDC-CERL). The CERL principal investigator was Edward T. Nykaza. The research team would like to acknowledge Larry Pater, Bob Baumgartner, and George Luz for their input, guidance, and support during the planning phase of this project. The team would also like to thank Bob Cvengros for his work on processing the data, and Bruce MacAllister and Jeff Mifflin for their hard work in the field during the data-collection phase of this research. William Meyer is Chief, CEERD-CN-N. Dr. John Bandy is Chief, CEERD-CN. Alan Anderson is Technical Director, CEERD-CV-T. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the US Army Engineer Research and Development Center (ERDC), US Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.

1 Introduction

1.1 Background

1.1.1 Blast noise and community impact

In the United States, the number of people living near military installations is steadily growing. The US General Accountability Office (GAO) reports that "urban growth near 80% of its (DoD) installations exceeds the national average" (GAO 2002). This suburban sprawl, combined with the escalation of military activities over the past decade, has heightened the potential for noise generated by US military installations to negatively impact surrounding communities.

For many years, one of these sources of noise, military blast noise, has caused community disturbances and resulted in legal actions against US military installations. Blast noise—the noise generated by large weapons, artillery, and explosions—is unique in that it is both impulsive and high energy, with the majority of the sound energy being concentrated from 10–100 Hz. Because of the high levels at low frequencies, blast noise is notoriously difficult to mitigate and can propagate long distances with minimal attenuation. As a result, the noise footprint from any blast-creating training or testing exercise on an installation often extends many tens of kilometers into the surrounding communities. Furthermore, due to the strong dependence on immediate atmospheric conditions, this footprint can be highly anisotropic —levels in opposing directions can vary by as many as 50 dB in unweighted peak level (Zpk)— so while one neighborhood may be barely able to hear the blasts, another may be exposed to peak levels in excess of 130 dB Zpk. To compound the problem, blast noise occurs intermittently; there are typically short periods of intense activity followed by long periods of relative silence, and so relating average noise levels to community response reveals an inaccurate picture of how blast noise is impacting the community on a daily, weekly, or even monthly time scale.

Nevertheless, to assess the impact of these activities on the surrounding communities, US military noise impact standards are currently based on the percent of the population that is likely to be highly annoyed by the noise (%HA) as a function of the C-weighted yearly average Day-Night Level (CDNL) (HQDA 2007). This method of assessment was adopted for consistency with the method recommended by many Federal agencies to

assess transportation noise impacts—the percent highly annoyed as a function of the A-weighted Day-Night Level (ADNL) (Schultz 1978). It has been recognized for some time, though, that the average sound level is an inadequate predictor of annoyance; the percent of the population highly annoyed by a given noise source is only weakly correlated with the Day-Night Level (CHABA 1996; Valente et al. 2011), and this correlation shows large variance from community to community (i.e., some communities are more tolerant of a given noise source than others [Green and Fidell 1991]).

Because of this poor correlation between the subjective and objective measures, as well as the paucity of data that exists to relate the percent highly annoyed to the CDNL for blast noise, Army regulations recommend supplementing the %HA vs. CDNL method with single-event peak measurements to predict the risk of receiving blast noise complaints (Pater 1976). Neither method, however, fully meets the US Military's noise management needs. The primary reason for the failure of the current methods is that they do not accurately capture the way humans respond to blast noise. They do not provide military installations with useful guidelines to manage day-to-day operations, and are not able to adequately predict blast noise annoyance, and consequently increase the likelihood of receiving complaints (HQDA 2007).

This is a significant issue; both large and small-scale complaint actions and community annoyance have resulted in the cessation or postponement of testing and training activities, and in some cases have closed down active ranges altogether. Changes in training due to blast noise complaints range from complete closure of all heavy weapons ranges (Fort Belvoir, VA; Fort Ord, CA; Camp Edwards, MA; Fort Devens, MA) through closure of some ranges or firing points (Fort Sill, OK; Fort Lewis, WA; Camp Blanding, FL; Camp Bullis, TX; Fort McClellan, AL; Fort A.P. Hill, VA) to curfews (Fort Benning, GA; Fort Knox, KY) or limits on the size of explosions (McAlester Army Ammunition Plant, OK, Aberdeen Proving Ground, MD). More adequate prediction and assessment methods are therefore necessary to protect public welfare and quality of life, while at the same time maintaining the combat readiness of troops.

1.1.2 Annoyance and non-acoustical factors

Determining the causes of an individual's level of annoyance to a noise source—or even predicting the likelihood of complaints—is notoriously difficult. Furthermore, previous research done in support of Strategic Environmental Research and Development Program (SERDP) Project WP-

1546 showed that complaints are not necessarily representative of the general opinion of the noise (Nykaza et al. 2012). The difficulties associated with assessing these responses are not entirely surprising; an individual's perception of their noise environment is predicated by their own psycho-physical features, past experiences, and personal viewpoints. Many factors enter into this relationship, such as demographics, attitudes and beliefs, or beliefs related to political and economic factors. The ability of the individual to habituate to noise, and the extent to which they are sensitive to noise in their surroundings may also contribute to annoyance.

1.1.3 Project overview

The overall objectives of SERDP WP-1546 (Pater et al. 2007) are to:

- enhance the understanding of community attitudes toward military blast noise
- develop a methodology to accurately predict human response to military blast noise
- recommend guidelines to minimize blast noise impacts on sustainable training and public welfare.

To meet these objectives, a series of studies that focused on understanding human response to military blast noise have been completed to date:

- a sleep disturbance study that identified a preferred time to conduct nighttime training (Nykaza et al. 2009)
- a personal interview study that looked at the language residents use to describe their environment and noise (Hodgdon et al. 2009)
- a complaint survey that looked at the relationship between complaints and annoyance (Nykaza et al. 2011)
- a complaint-risk study (Nykaza et al. 2008b).

The General Community Survey (GCS) results presented in this work are the first of three GCS efforts within SERDP WP-1546. In addition to the GCS, which is studying communities' response to blast noise over a long time period (i.e., a month and a year), two SERDP-funded in situ studies will be conducted at Study Sites 2 and 3. The in situ efforts will study how individuals respond to blast noise over a short time period (i.e., individual events or groups of events that occur on a given day). Collectively, the results from the SERDP-funded GCS and in situ studies, and ERDC-funded sleep and complaint studies will be used to meet the overall SERDP WP-1546 objectives.

1.2 Objective

The objective of this work was to construct and administer the GCS at a military installation (Site 1) to determine how blast noise levels affect general community annoyance and how the community reaction changes over time in response to a dynamic blast noise environment.

1.3 Approach

This study completed the GCS study at the first (of three) US military installations. Since the GCS study is designed to determine the perception of a given individual within a community regarding noise, and to compare the perceptions of that individual with other community members, this study used two sampling procedures:

1. A cross-sectional sample to investigate how the community response changes as the blast noise environment changes
2. A panel sample to investigate how individual's response changes over time.

This work details the results of the cross-sectional GCS performed at the first of three study sites. The panel survey results from this first effort will be summarized and included in the next GCS report, which will include two additional of Army installations.

1.4 Mode of technology transfer

This report will be made accessible through the World Wide Web (WWW) through URLs:

http://www.cecer.army.mil

http://libweb.erdc.usace.army.mil

2 Survey Methodology

2.1 Survey design

The GCS was designed to highlight similarities and differences between peoples' responses to noise, not only in terms of annoyance, but also activity interference, sleep disturbance, and other non-acoustical factors. The goal of the survey was to determine how to best assess community response within a given noise environment in a way that allows for comparisons of individual responses to different situations, and that affords comparison between different individuals. This section discusses the survey instrumentation —the questionnaire developed to collect subjective measures of noise exposure— and the sample design to represent communities near the military installation.

2.1.1 Survey instrumentation

The questionnaire for the General Community Survey (GCS) was developed in conjunction with survey instruments for other components of this research project. In particular, measures of noise reaction, attitudes about the neighborhood, and beliefs about the ability to become accustomed to noise were designed to be comparable across the complaint survey as well as daily- and event-surveys completed by in situ participants. Qualitative interviews conducted as part of the Personal Interview Protocol (PI) (Nykaza et al. 2010) also informed the development of survey measures and ensured that language and phrasing in the standardized survey questions were consistent with that used routinely by individuals. The survey instrument was reviewed and approved by the Office of Management and Budget (OMB No: 0710-0015) as well as the Pennsylvania State University Office of Research Protections Institutional Review Board (IRB No. 27457).

Altogether, the GCS questionnaire included a total of 43 questions, including two annoyance questions. Table 1 lists the topic areas and specific elements of the survey questionnaire; the full questionnaire is provided in Appendix A. In addition to noise annoyance ratings, the questionnaire captures factors that can affect how individuals experience noise, such as demographic characteristics, attitudes about noise, and perceived ability to habituate.

Table 1. Topical outline of the GCS questionnaire.

Topic Area	Specific Elements
Social and demographic characteristics	Household size, presence of children.
Satisfaction with neighbor-hood	Quality of neighborhood and perceive neighborhood as quiet or noisy. Duration at current residence, ever consider moving due to noise.
Annoyance ratings for common neighborhood noises	Annoyance with each source of noise in past 12 months (in past 4 weeks): ▪ barking dogs ▪ thunder ▪ street traffic ▪ commercial aircraft ▪ military aircraft ▪ military ground vehicles ▪ small military gunfire ▪ large military gunfire, bombs, or explosions.
Frequency of noises in the neighborhood	Frequency each source of noise heard in past 4 weeks: ▪ street traffic ▪ commercial aircraft ▪ military aircraft ▪ military ground vehicles ▪ small military gunfire ▪ large military gunfire, bombs, or explosions.
Timing of noise events	Times of day noise in the neighborhood are most disturbing.
Rattle and vibration	Rattle or vibration due to military gunfire, bombs, or explosions. What structures in home rattle or vibrated?
Interference with activities	In the past 4 weeks, if noise or rattle from military gunfire or bombs: ▪ interfered with conversation inside the home ▪ interfered with conversation outside the home ▪ disturbed other activities inside the home ▪ disturbed other activities outside the home.
Sleep disturbance	Ever awakened by noise from outside, and the source of this noise. How frequently awakened by this noise in past 12 months, in past 4 weeks.
Other reactions to noise	Frequency of other reactions to noise in past 12 months: ▪ startle or make you jump ▪ frighten ▪ cause you to feel irritable or edgy ▪ make you tense or nervous.
Relationship with the military and Installation 1	Anyone in household employed at Installation 1, ever serve in Armed Services, or receiving retirement or disability income from Armed Services? Rating of importance of Installation 1 for local economy. Aware of noise from installation prior to moving to the area.
Potential exposure at residence	Hours typically at home during weekdays during daytime, evening, and nighttime hours.
Housing characteristics	Age of home, style of house, and type of construction. Age of most windows and type of window construction.
Hearing capacity	Have normal hearing, use a hearing aid.

Environmental factors that shape human response to noise include the level and number of noise events, the timing of the noise event (daytime or nighttime), and the structural features of the house and windows. By including a range of measures as well as annoyance ratings, the subjective data will be better able to detect variation and to demonstrate consistency in the responses obtained from the participants.

Measures of annoyance with noise are the primary outcomes of interest, and the questionnaire adopted recommendations from the International Commission on the Biological Effects of Noise (ICBEN). This team of international noise researchers recommended that researchers adopt standard question wording and response formats (Fields et al. 2001). ICBEN suggests that researchers include two standardized questions to facilitate comparisons across social surveys. One of these questions uses a response format with five categories that are fully-labeled and read aloud (or read by) the participant: (1) not at all, (2) slightly, (3) moderately, (4) very, and (5) extremely. The second question uses an 11-point (0 to 10) response scale that labels only the end points (not at all, extremely). The GCS uses only the full-labeled (five category) verbal response format to reduce respondent burden.

2.1.2 Sample design

The GCS proposed a 9-month sample plan that included two types of households: (1) a cross-sectional sample of households selected each month, and (2) a panel sample of households first surveyed in months 1–3 and re-interviewed in months 79. Table 2 summarizes the sample design, which called for surveying approximately 50 households each data-collection interval and re-interviewing a subsample of households that were first interviewed during Intervals 1, 2, or 3. Although this work focused on data and results from the cross-sectional surveys only, an understanding of this data can be useful to clarify the survey design in which the cross-sectional data are embedded.

Table 2. GCS sample plan.

Month	1	2	3	4	5	6	7	8	9	Total
Panel	50	50	50	0	0	0	50	50	50	300
Cross-section	50	50	50	50	50	50	50	50	50	450
Total	100	100	100	50	50	50	100	100	100	750

2.1.3 Selection of survey areas

The GCS sample plan is based on the assumption that individuals living in relatively close proximity experience the same noise environment. That is, the *survey population*, or group about which this study intends to generalize, is defined by geographic boundaries and includes all individuals residing within those boundaries. Self-reported reactions to military blast noise, or other sources of noise, collected through social surveys of representative samples of individuals in these areas will yield valid measures of annoyance for the corresponding population.

Two other factors were important to define the survey populations for the GCS. First, the geographic areas should be relatively small to maximize homogeneity of the noise environment—i.e., all individuals within the area are exposed to the same stimuli. At Installation 1, the geographic areas were overlaid with a mapped grid that demarcated cells representing regions with an area of 1 km^2, and the survey population for a designated area was defined by 1-km^2 cells. The addresses or residential housing units within that area served as the sample frame (list of cases) from which to select a sample of individuals (one adult per housing unit) exposed to that noise environment.

Second, the geographically-defined survey populations must be in close proximity to noise monitoring instruments. Statistical analysis of the survey data included comparisons of objective noise metrics with subjective responses. Ensuring that survey populations were clustered tightly around noise monitors would enhance the validity of these comparisons and mitigate the influence of other factors that may undermine or weaken the comparison (e.g., geographic terrain, distance).

Guided by these factors, the study area for Installation 1 included 30 distinct geographic areas. The large number of areas made it possible to assess human response to blast noise across a wide range of received levels, and at residences in both urban and rural areas. Each site had noise monitors in the immediate area that recorded measurements of the noise environment. Importantly, the GCS survey design included not only the collection of a target number of total surveys during each data-collection interval, but also a roughly even distribution of surveys by geographic site each month.

2.2 Noise data collection

Blast noise was recorded using a set of 37 Larson Davis 870 sound level meter noise monitors located on and around the installation* (Figure 1). These monitors recorded every event that exceeded a threshold value of 105 dB unweighted peak over the entire 9-month period that the GCS was being administered. The threshold value for several monitors was set lower than 105 dB at various times throughout the experiment by installation personnel, presumably due to institutional needs to compensate for such things as increased numbers of wind triggers or event densities related to fluctuations in training schedules.

Note that the noise monitoring equipment (sound level meters) used for the GCS Site 1 is different than the equipment (16-bit data recorders) that was used for Study Site 2 and will be used at Study Site 3. For this first GCS effort, the research team used noise monitors that the participating installation already had in place and running. These monitors, demarcated by triangles in Figure 1, were located on the perimeter of the installation and in surrounding communities. Unfortunately, several problems with these monitors prevented perfect collection of blast noise data. For example, the noise monitoring equipment did not have any built in detection or classification software, nor did it record the entire pressure time series for captured noise events. The equipment output only traditional sound pressure level measurements (e.g., the peak level and sound exposure level), and could not calculate additional metrics during the post-processing.

2.3 Post-processing of noise data

2.3.1 Range data processing

The installation made range records available that contained information including the locations of active ranges, times of active firing windows, types of weapons, intended number of shots from guns and explosive weights from detonations. Because this study focused solely on large arms and large explosions, entries for small or medium arms or small detonations were excluded from the records. Small detonations and medium arms were defined respectively as explosive weights less than 1 lb or guns of size less than 75 mm.

* It should be noted that the installation map is purposely left vague to protect the identity of the installation in this report. The on-post monitors are left on this map, despite the fact that they were not used in this study to better show the reader the approximate location of the installation.

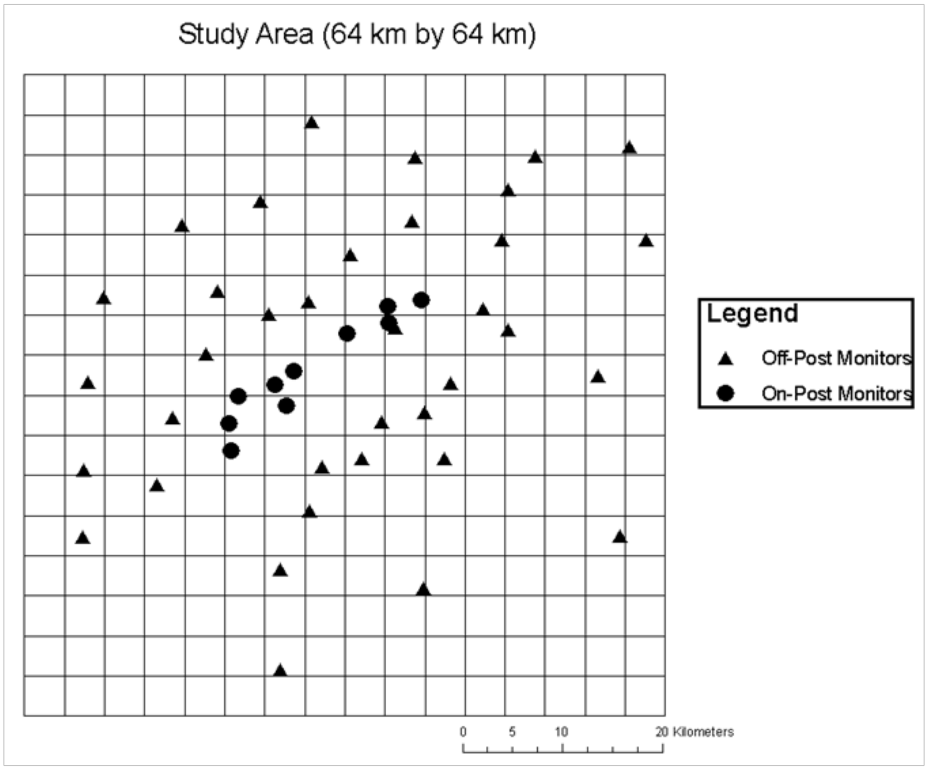


Figure 1. Location of noise monitors at Study Site 1. Triangle markers represent the noise monitors used for this study.

Also, if the firing site was an indoor range or a range that fired only small arms, these intervals were excluded. Furthermore, if the time window included midnight (suggesting that the firing window was a placeholder and not an actual firing time) or reported zero fired rounds, it was excluded. Ranges with more than one weapon in use in the same time period had the information from all relevant weapons (large arms or detonations) combined into a single entry. The qualified range records were placed in chronological order by end time first and then by start time and any duplicate firing windows were eliminated. This procedure resulted in a list of large arms training intervals, their locations, and the weapons active at each place and time.

2.3.2 Noise monitor data

Of the 37 monitors that recorded data, two were excluded because of calibration problems. The on-post monitors were also excluded because of an increased uncertainty of identifying the true source location of nearby loud noise events. Ambiguity in source location could potentially lead to large errors in extrapolated levels if the monitor were much closer than expected to the source. In the end, the outputs from 32 noise monitors were included in the analysis.

Every event triggered on the monitors was not necessarily a blast. Based on previous work, events were classified as a blast if the difference between the maximum exponentially fast-averaged C-weighted sound pressure level (CLMAX) and the C-weighted sound exposure level (CSEL) was greater than 4.8 dB. This classification scheme was found to have an accuracy of 90%. Because some of the monitors had lower thresholds throughout the course of the experiment, the 105 dB threshold was enforced at all monitors via post-processing, excluding all events below this level from analysis. Also, in an isolated case, a monitor appeared to be triggering on a different metric than others—for example, CSEL instead of unweighted peak. The shifting trigger levels or settings may have led to some inconsistency in reported numbers of events at the lower levels (which might be selectively excluded at some sites and not others). This should not, however, affect the accumulated peak levels or numbers of higher level events.

For the higher level events (those which when extrapolated from the assumed source position to the average monitor distance are greater than 135 dB), a corroboration stage was employed in which a blast had to be registered at more than one site within a 1-minute time range of the recorded event to be accepted. This was the result of seeing unusual numbers of what were deemed unrealistically loud recorded events at only certain sites, with little corroboration at others. Distributions of events received at each monitor were examined in an effort to identify any groups of abnormal events. Most monitor-specific event levels followed a roughly exponential distribution of occurrence with the maximum at the approximate threshold value and decreasing prevalence as level increased.

2.3.3 Extrapolation of blast noise levels

The Universal Transverse Mercator (UTM) coordinates of the home of each of the participants in the survey were used to determine which monitors were within 10 km. To increase specificity and accuracy of noise assessment, only these monitors were employed in the procedure to extrapolate blast levels. The date of the survey was used to determine the events that had taken place within the past 4 weeks, and those that had occurred within the past 12 months. Events were assumed to originate from the active range nearest to the receiving monitor. If no ranges were active at that time, then the event was assumed to be falsely classified as a blast and was eliminated. To compensate for the possibility of multiple monitors receiving a blast, each event received at a monitor in range of a subject's house within a minute of an event received at another such

monitor is processed to eliminate duplicate reporting to the extent possible. The level at the closest monitor is chosen as the most representative. Notwithstanding this process, predictions of individual blast exposure typically included greater numbers of received events if there were more monitors in range.

The metrics evaluated in this study were all level-type metrics and so could be reasonably extrapolated or interpolated from the monitor to subject homes using:

$$L_h = L_m + 20 \log_{10} R_{ms}/R_{hs} \quad \text{Eq. 1}$$

where:

L_h = the predicted level at the subject's home
L_m = the level at the monitor
R_{ms} = the distance from the monitor to the source location
R_{hs} = the distance from the subjects house to the source location.

This equation accounted for spherical spreading, but clearly does not account for potential atmospheric effects. This is an important reason for only allowing input from nearby monitors rather than including all monitors for all events.

After processing, two main outputs were produced: (1) a subject-specific record of all of the unique blast events recorded by monitors with 10 km of the subject's house, and (2) cumulative metrics, which were based on the values of the individual events for that subject's location over the past 4 weeks and 12 months. These were incorporated into a summary record that contained summary metric information from all subjects as well as survey identification numbers so that it interfaced with the survey data.

2.4 Statistical analyses

2.4.1 Data preparation

To analyze the data from the summary record, a mixed effects linear model was implemented using SAS® (Statistical Analysis Software). The data were prepared for analysis by initially determining how the individual survey questions would be included in the analysis (see Appendix A for a complete list of the survey questions). Some survey questions were included directly in the analysis, others were either combined with one another or altered to create new variables, and some were omitted entirely. First, any open-ended questions on the survey were excluded from the analysis; these include A6, A7, A9 (*neighborhood likes/dislikes*), C8 (*source of*

awakening) and H9a (*moving)*. The few questions on the survey that require a quantitative response (as opposed to a response from a listing of possible categories) were identified and these questions were considered as potential covariates. These questions include A1 and A3 (*household variables*), B24 (*time of day noise most disturbing*), and G1-G6 *(times of day at home*). B24 was dropped from the analysis because the responses could not be fit logically into the model. For the Questions A1, A3 and G1-G6, the highest correlation with annoyance was due to Question A3 (*number of 18+ year old people in household*), and this explains less than 0.12% of the variation in the annoyance values. As a result, all of these possible covariates were dropped from consideration. The remaining survey questions were considered as response variables or factors for direct inclusion in the model or for combination to form new variables.

In Section A, all remaining questions, i.e., A2, A4, A5, and A8 (*household and neighborhood characteristics*), were directly included as factors in the model. In Section B, Questions B1-B16 (*common neighborhood noises*) were used as response variables. For each respondent, these 16 responses were stacked into a single column called "annoy," and two new variables were created called "source" and "time." The source variable denotes the eight different noise sources referenced in these questions, and the time variable differentiates between the 12-month (long-term) and the 4-week (short-term) annoyance response. Questions B17-B22 *(transportation and military noises)* ask how often the respondent heard each of the last six noise sources (omitting dogs and thunder) in the last 4 weeks. These questions are included in a variable called "heard," which has a missing value for the first 10 entries for each respondent but contains the values of B17-B22 for the last six entries.

In Section C, the Questions C1 and C2_1-C2_15 (*rattle and vibration*) were used to create a factor called "totalrat," which indicates one of three states, either: (1) no noticeable rattle or vibration from the military activity, (2) noticed just one thing ever to rattle or vibrate, or (3) more than one thing. Questions C1 and C3-C6 (*vibration, rattle. and noise effects over the past 4 weeks*) were used to create another factor, called "effect4wk," where the name comes from the fact that C3-C6 ask about the disruptive effect of military noise/rattle in the last 4 weeks. This variable indicates one of three states: (1) the respondent did not notice any military rattle or vibration, (2) the respondent noticed the military rattle/vibration but was never disrupted by it, or (3) they were disrupted in at least one way. The data from Questions C7-C10 (*awakened by noise*) were too sparse to be useful in the quantitative analysis and were therefore omitted.

In Section D, only four questions, D1-D4 (*12-month noise effects*), ask about the effect the noise has had on the respondent in the last 12 months. Since these questions were highly intercorrelated (Cronbach's Alpha = 0.82), they were averaged to create a possible covariate called "effect12mo." Cronbach's Alpha is a measure of internal consistency that indicates how closely related sets of items are as a group.

The five questions in Section E all try to evaluate the tendency of a respondent to habituate to a noise source. With the exception of E1, all questions are written so that higher values of the response indicate greater ability to habituate. As a result, E1 was reverse coded so that a 1 is transformed to a 5 and a 2 to a 4, and vice versa; a response of 3 remains unchanged. These five questions were examined for intercorrelation, and Cronbach's Alpha was 0.68, but would increase to 0.75 if E1 were removed from the list, indicating that people generally responded to E1 differently than they did to E2-E5 (possibly because of the fact that it asked the question in reverse order). As a result, E1 was excluded from the group and E2-E5 were averaged to create a self-reported habituation index.

Section F has five questions; the first three ask about connections to the specific military installation, the Armed Forces and the Department of Defense. These responses were used to create a new variable called "wrk4mil," which takes the value "Yes" if a respondent indicated connections in any one of these questions, and otherwise takes the value "No." The last two questions are averaged to create another possible covariate called "inst_impt," indicating the economic importance of the military installation.

In Section H, all remaining questions from H1-H10 (*years at address, house construction variables*) are included directly as factors and H11 is excluded due to the lack of responses; all remaining survey items were comments from the interviewer and were therefore omitted from the quantitative analysis.

2.4.2 Model development and selection

The 1-5 Likert scale ranking of annoyance is considered to be a continuous response variable. The response was repeatedly measured for eight different noise sources in each of two time periods, asking for recall over the past 4 weeks and the past 12 months. Because both continuous and categorical predictors (covariates and factors, respectively) were included in the model, an Analysis of Covariance (ANCOVA) was performed.

The final covariates considered for inclusion were *habituation*, *effect12mo*, *inst_impt*, and *heard*. After attempting to fit the model with *heard*, it was excluded from the model as it forced the omission of all annoyance ratings from the first 10 of 16 annoyance questions on the survey. Finally, the model consisted of three possible covariates and 20 possible factors, namely *a2, a4, a5, a8, h1, h2, h3, h4, h5, h6, h7, h8, h9, h9b, h10, totalrat, wrk4mil, source, time*, and *effect4wk1*. After some work on the model, it became apparent that *effect4wk1* and *totalrat* could not both be included in the model because they were both defined in conjunction with survey Question C1, and were therefore redundant in some regard. This caused estimation stability issues, and thus *effect4wk1* was excluded from the analyses.

In some initial attempts to model these repeated measures using ANCOVA, attempts were made to include varying numbers of interactions, with some such attempts causing the estimation routines for the model fitting to never converge. This indicated that the model was oversaturated, so the scope of the model had to be greatly reduced in terms of which interactions were included. The model was therefore reduced to one that considered the 19 main effects of the factors, and that included the factor interaction for time and source.

One of the primary objectives of the study was to determine if the response patterns differ over the 4-week and 12-month time periods. To ensure that this difference did not depend on the noise source, this interaction was evaluated. Aside from this factor interaction, all three covariates were included and their interactions with the 19 main effects of the factors and the time*source interaction. A regression model with the annoyance response and all three covariates was run to obtain VIFs (variance inflation factors) to ensure that there was no multicollinearity among these covariates. The final model obtained after model reduction included some significant interactions between all covariates and some main factor effects, but for effect12mo and inst_impt (*importance of installation*) the main effects of the covariates were not significant in this final model; the main effect of the habituation covariate was significant. As a result, and to improve the interpretability of the model output, the effect12mo and inst_impt covariates were dropped and the model was refit without these two covariates and any of their interactions.

The final model included terms for the 19 factors and one factor interaction, the main covariate effect, and the 20 covariate-by-factor interactions, for a total of 41 terms. It also included a doubly repeated measures com-

mand to note that the responses for a given individual over the eight different noise sources were correlated (all equally correlated and all noise sources with equal variance, i.e., compound symmetric covariance structure) and that the responses over the two different time periods were also correlated (possibly different variances among the different time periods, i.e., unstructured covariance structure).

The initial model was fit and the assumptions were checked with residual plots. The process indicated that the homoscedasticity assumption was verified. There was some slight right skewing observed in the data, but given the amount of data, and the well-known fact that the ANCOVA procedure will be robust to the normality assumption, the model reduction was continued.

The first step in the continued reduction of the model was to check whether the interactions were significant. If the interaction p-value was greater than 0.20, the term was dropped and the model refit. Once all interaction p-values were less than 0.20, the main effect p-values were then evaluated. A main effect was considered for elimination if it was not included in any interactions that still existed in the model. This iterative model reduction process continued until all terms in the model had p-values less than 0.20. At that point, the model reduction is stopped and a determination was made as to which terms were statistically significant, as assessed at the 0.05 significance level.

3 Results and Discussion

3.1 Data collected

3.1.1 Overview of survey data collected

The GCS at Installation or Study Site 1 began 1 June 2009 and was completed 3 February 2010. All interviews were conducted by telephone from Tetra Tech's in-house telephone survey lab in Madison, WI. The survey questionnaire was programmed for execution using Computer-Assisted-Telephone-Interviewing (CATI) software to support collection of high quality data and manage sample for maximum effort. The number of interviewers and the level of interviewing effort was closely monitored and managed to ensure the target number of interviews for each data-collection interval were completed over a 4-week period — i.e., not too quickly but also not exceeding 4 weeks. In practice, the target number of interviews was completed for each data-collection interval in 4 weeks or slightly less. When the target number of completes was reached before the conclusion of a 4th week, the sample was held until roughly the end of that period before starting the next round of data collection.

As discussed in Section 3.1.3, the survey population for each of the 30 study sites was defined by a mapped grid cell that represented an area of 1-km^2. The interviewing effort focused first on households in the primary cell that were in closest proximity to the noise monitor.* Some of these cells mapped to sparsely populated areas such that the sample was not sufficient to achieve the target number of completed surveys across the 9-month period. When sampling in the primary cell was exhausted, the sample area was expanded to include the eight adjacent surrounding cells (i.e., expanding outward from the center much like a concentric circle). Over the course of the study, 17 of the 30 sites had to be expanded to include the eight adjacent cells; of these 17, five had to be expanded a second time.

* Not all households in the study areas were available for the General Community Survey sample. The Complaint Survey was conducted in communities near this same installation 2 months prior to the start of the General Community Survey. Since the Complaint Survey had similar questions and related study objectives, households sampled for that survey were excluded from the population and were not eligible to be interviewed for the General Community Survey.

3.1.2 Modified sample plan

The research team modified the sample plan in early October 2009. Due to factors outside the team's control, noise monitors furthest away from the installation were removed in October 2009. The social survey responses—without measurements from the noise monitors in the area for a comparable time period—would not meet data requirements for the statistical analysis. The removal of the noise monitors affected continuation of the cross-sectional data collection in Intervals 5 through 9 as well as the panel study.

To minimize the impact of losing data for these areas, the team modified the study design. Interviews were not conducted with households in Sites 16 through 30 after 31 October 2009, the date after which noise monitor data would not be available. Starting 1 November 2009 the data collection continued only in Sites 1 through 15. The team expanded the geographic boundaries for several of the sites within the full set of Sites 1 through 15 to support the sample size requirements for the remainder of the 9-month study period.

As a result of these changes, the number and timing of the implementation of the GCS differed from the original plan. Table 3 lists the number of completed surveys in each data-collection interval. Due to the loss of the noise monitors, the number of surveys for the panel study during the first three intervals is shown as zero because they could not be randomly selected as a subset of 50 households for follow-up interviews. Rather, all households that were interviewed in these months were eligible for a follow-up interview.

The total number of surveys achieved was more than originally planned (989 vs. 750) but fewer than planned for the panel survey (218 vs. 300). Specifically, 771 cross-sectional interviews were completed over the nine intervals of data collection. More than the minimum target of 50 interviews in Intervals 69 were conducted for two reasons. First, during Interval 6, an extra effort was made to complete as many interviews as possible in Sites 16 through 30 before the noise monitors were removed.

Table 3. GCS Installation 1: Achieved samples sizes.

Month	1	2	3	4	5	6	7	8	9	Total
Panel	0	0	0	0	0	110	41	33	34	218
Cross-section	100	100	101	50	50	125	74	67	104	771
Total	100	100	101	50	50	235	115	100	138	989

Second, it was increasingly difficult to manage the study sample to ensure that both the total target number of interviews for the month, and roughly equal representation in each site in each month were met. Given the large number of study sites, a small number of completed interviews in each site were needed to reach a total of 50 responses. It required a delicate balance of releasing sufficient sample to reach targets and placing sample “on hold” so that targets were not substantially exceeded. To ensure that each site was roughly equally represented in each data-collection interval, the minimum target per site was increased. With this strategy, the total target number of interviews met or exceeded the original plan and provided better coverage of individual study sites across data-collection intervals.

3.1.3 Overview of noise data collected

The noise levels for each household were calculated for two time periods: 12 months and 4 weeks prior to each participant’s survey. Because the 4-week data are a subset of the 1-year data, only the 1-year data are summarized here.

The 105 dB threshold criteria on the monitors resulted in the extrapolation of between 750 and 7115 events, depending on the date of the survey and the location of the household in relation to the monitors used for extrapolation. As discussed in Section 2.1, Army Regulation 200-1 recommends two methods for blast noise assessment: the %HA as a function of CDNL and a complaint-risk criteria, which states that that an unweighted peak level of 115 dB unweighted peak level (Zpk) is expected to cause a moderate risk of complaints. Figure 2 shows the distribution of the number of events that exceed the 115 dB complaint criteria in the year prior to the survey, calculated across all households. On average, 754 events exceeded the complaint criteria at any household; however, the range of threshold-exceeding events was quite large—from 76 events at one household to 2340 events at another. No households around this installation experienced less than 76 events over 115 dB. For the criteria that delineates a high risk of complaints (Zpk > 130 dB), Figure 3 shows that there were fewer events of this magnitude, yet some households experienced as many as 65 events with these levels over the year. Three hundred and nine households experienced from 1-5 events that exceeded the complaint criteria for a high risk of complaints, and on average, a household received 10 events that exceeded this threshold. Figure 4 shows the distribution of maximum Zpk levels (i.e., the maximum level experienced by that household over the entire year), across all households.

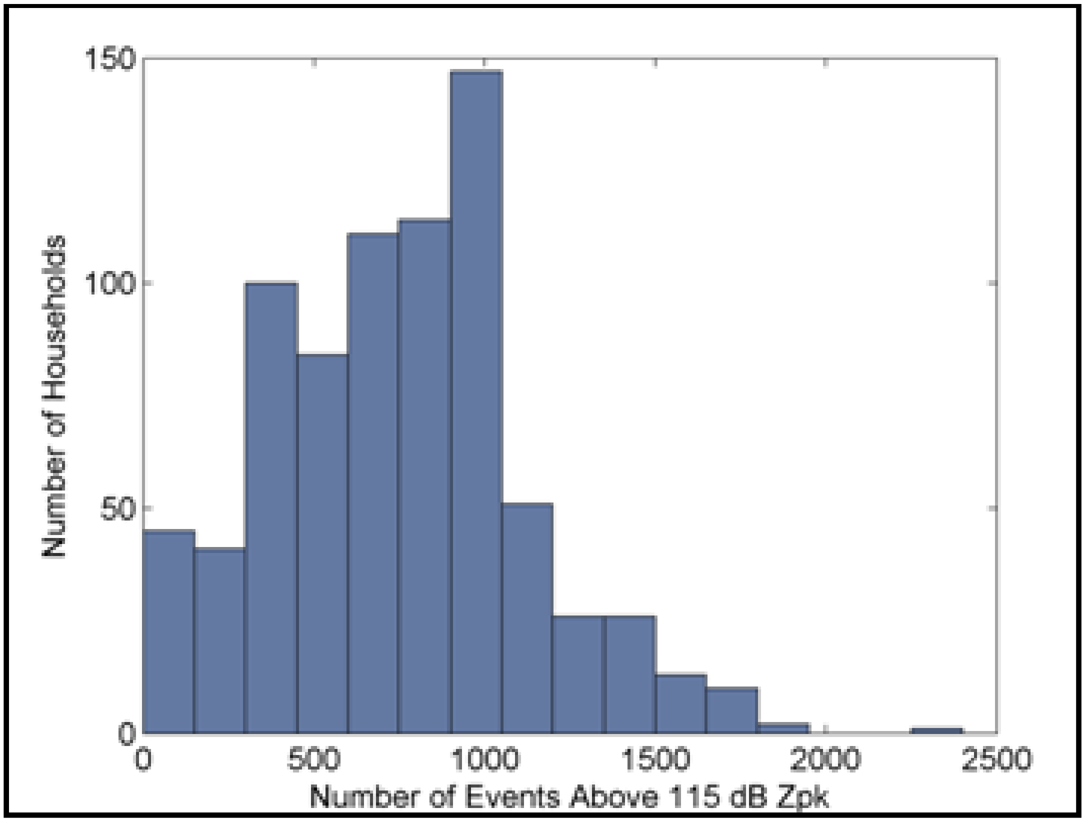


Figure 2. Distribution of the number of events above 115 dB unweighted peak level.

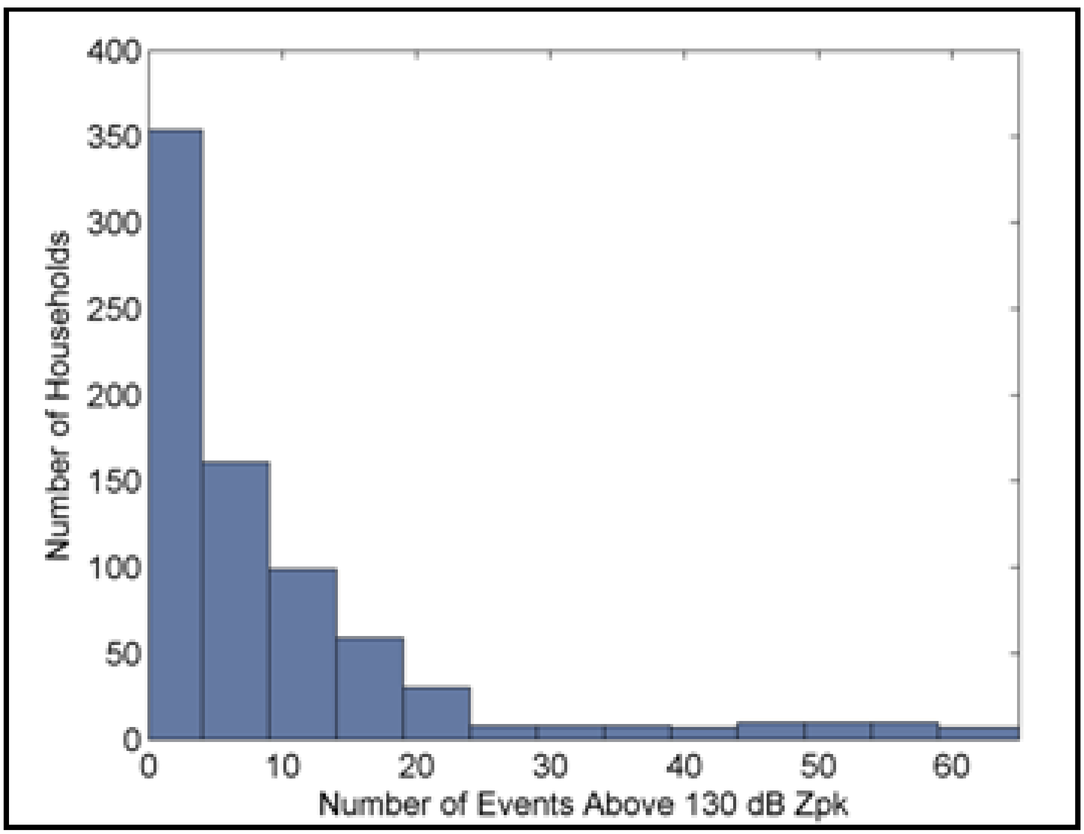


Figure 3. Distribution of the number of events above 130 dB unweighted peak level.

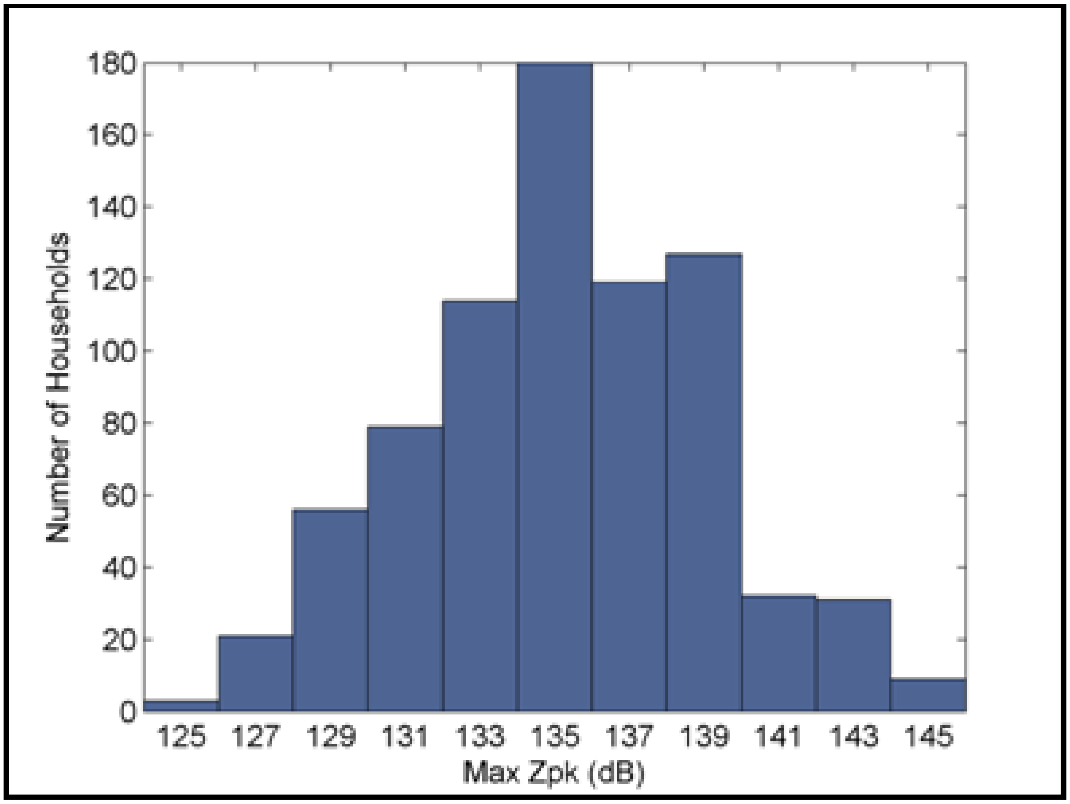


Figure 4. Distribution of maximum unweighted peak level Zpk received at households in the region around Site 1.

The average maximum peak level received at any household was 135.2 dB, with values ranging from 124.3 dB to 145 dB. The latter value is unrealistically loud, or at any rate, should be quite rare. This suggests errors in the extrapolation method, although the occurrence of an anomalous event cannot be ruled out. Alternate extrapolation methods are currently under investigation.

For consistency with current standards for noise assessment, Figure 5 shows the distribution across all households of the CDNL over the 12-month period. As expected, and in stark contrast to the large peak levels received at many households, the CDNL are relatively low—having an average value of 49.3 dB. These data highlight one of the major inadequacies with current assessment methods. The households around this installation are, on average, receiving maximum levels of 135 dB Zpk, which is expected to cause a high risk of complaints and approaches the 140 dB threshold for human hearing damage. The same households, however, are only exposed to an average CDNL of 49 dB, which is well below the compatible use zone threshold of a CDNL of 65 dB for residential use (schools, housing, and medical facilities).

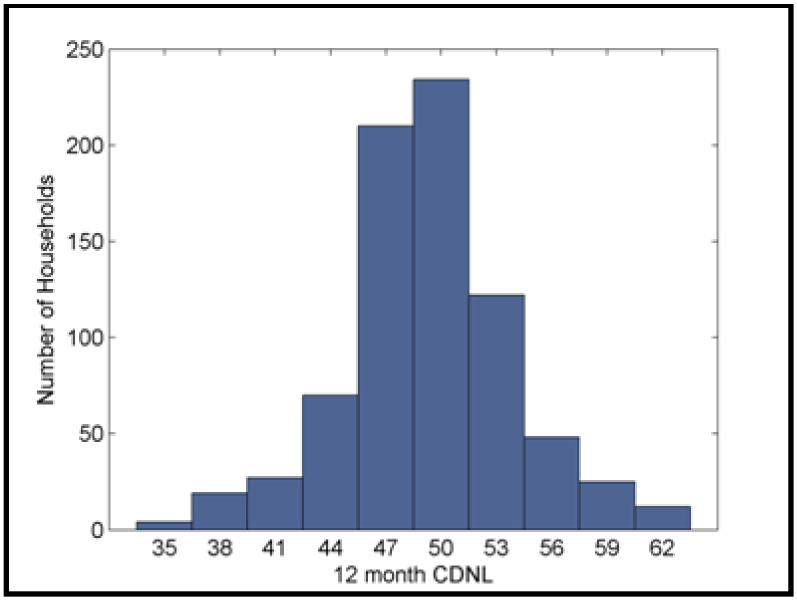


Figure 5. Distribution of yearly average CDNL in the region around Site 1.

3.2 Survey response results

Appendix A gives the distribution of the cross-sectional responses to all survey questions. In general, for Installation 1, it was found that the majority of the respondents participating in the study own their own home, live in households of two people (over 18 years old), and self-report having normal hearing. Most respondents rate their neighborhood as a good or excellent place to live and only 10% of respondents rate their neighborhood as noisy. Figures 6 and 7, respectively, show spatial distributions of the later two findings.

In terms of the installation, the majority of respondents reported that they were aware of installation noise before they moved into the neighborhood (Figure 8), would not move because of noise, and believe that the installation is important to the economic health of the area (Figure 9).

In terms of all noise sources surveyed, blast noise was the most annoying noise source in comparison to the seven other noise sources (i.e., barking dogs, thunder, street traffic, commercial aircraft, military aircraft, military ground vehicles, and small military gunfire). This was true for both the annoyance to noise events over the past 12 months and past 4 weeks. The noise sources that respondents living near Study Site 1 report hearing most often (i.e., those who report hearing the noise source moderately often, frequently, or very often) in descending order are: traffic noise (32%), blast noise (26%), small arms gunfire (10%), commercial aircraft (9%), military aircraft (6%), and military ground vehicles (1%).

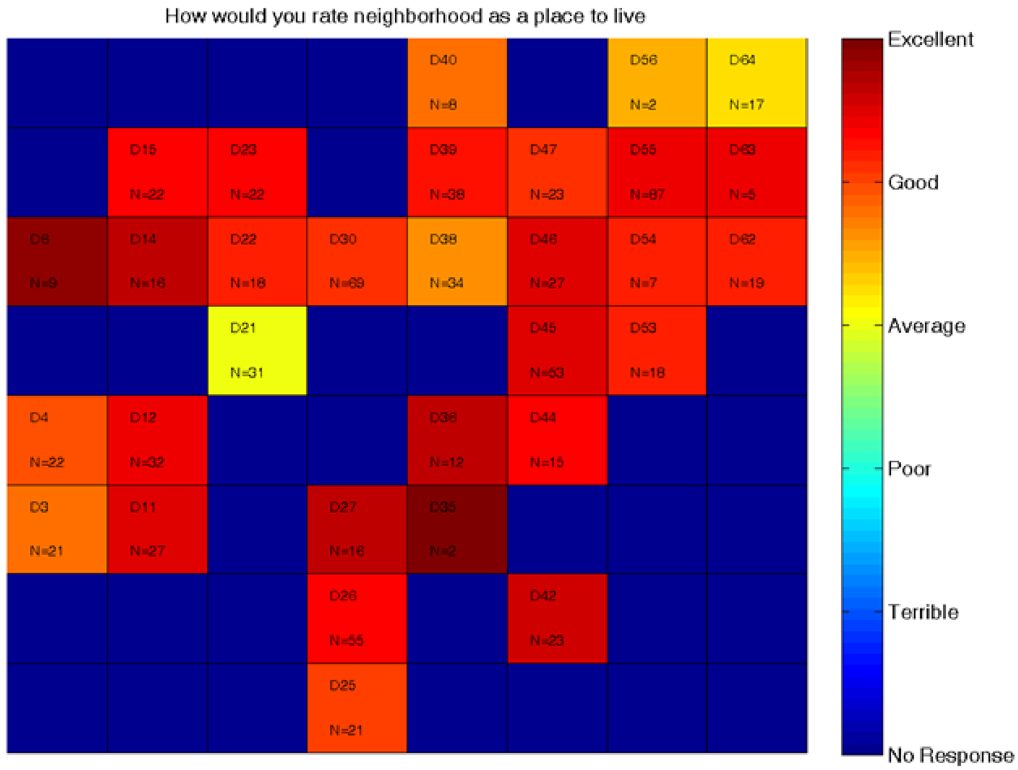


Figure 6. Spatial distribution of respondents' rating of their neighborhood.

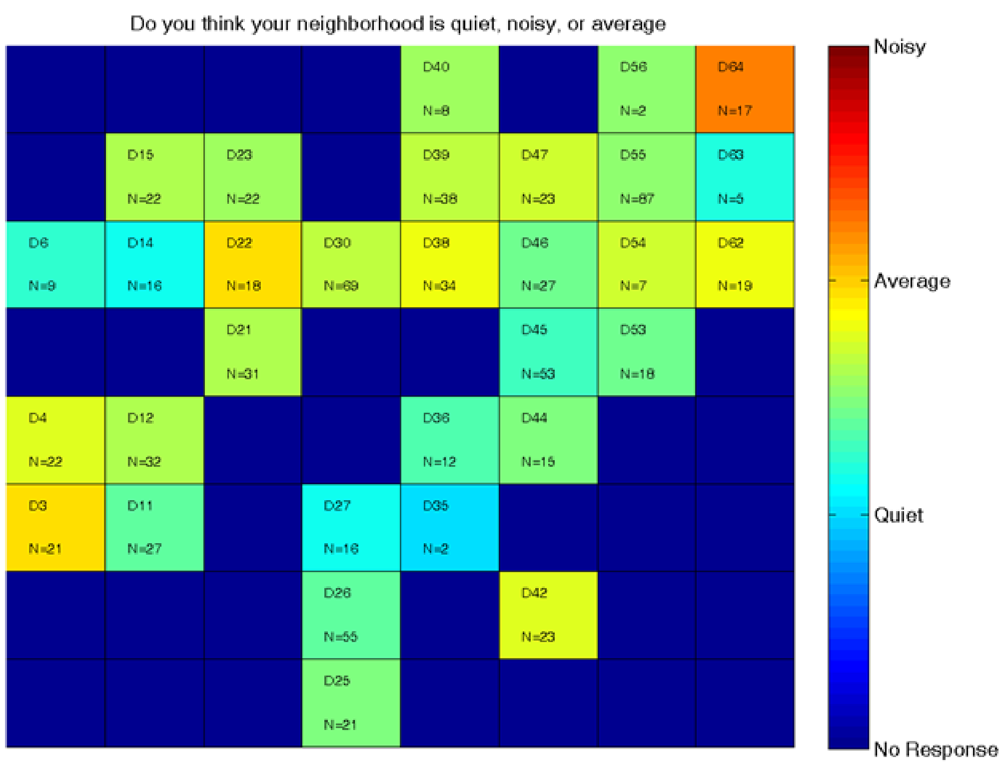


Figure 7. Spatial distribution of reported neighborhood noisiness.

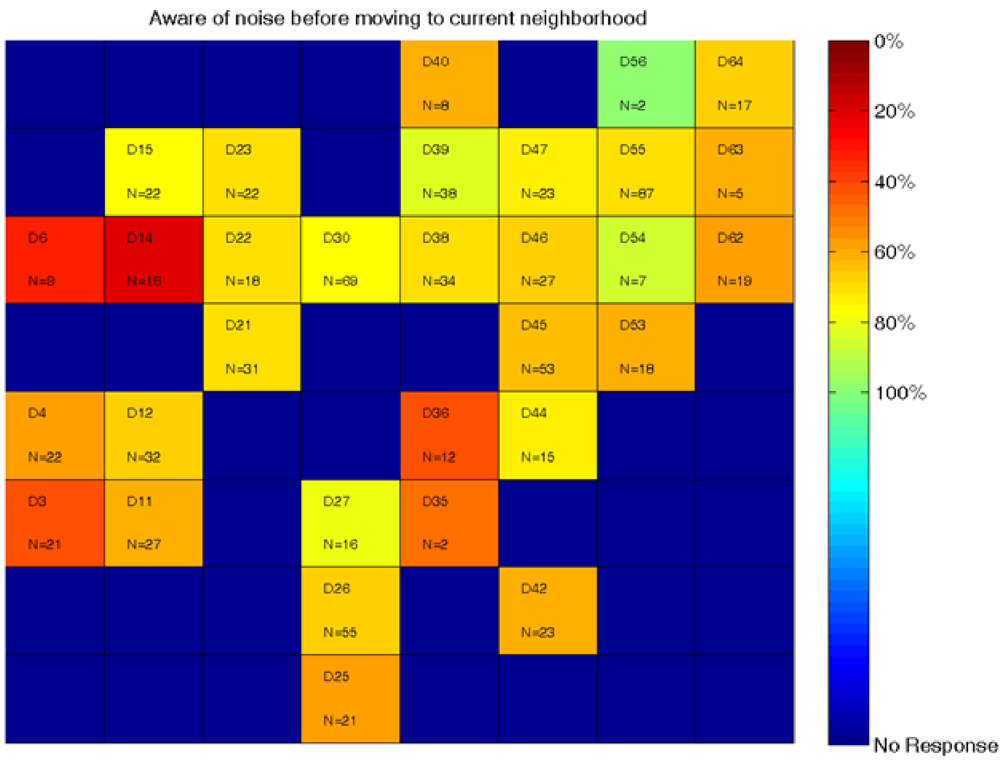


Figure 8. Spatial distribution of the percentage of respondents aware of installation noise before moving into the neighborhood.

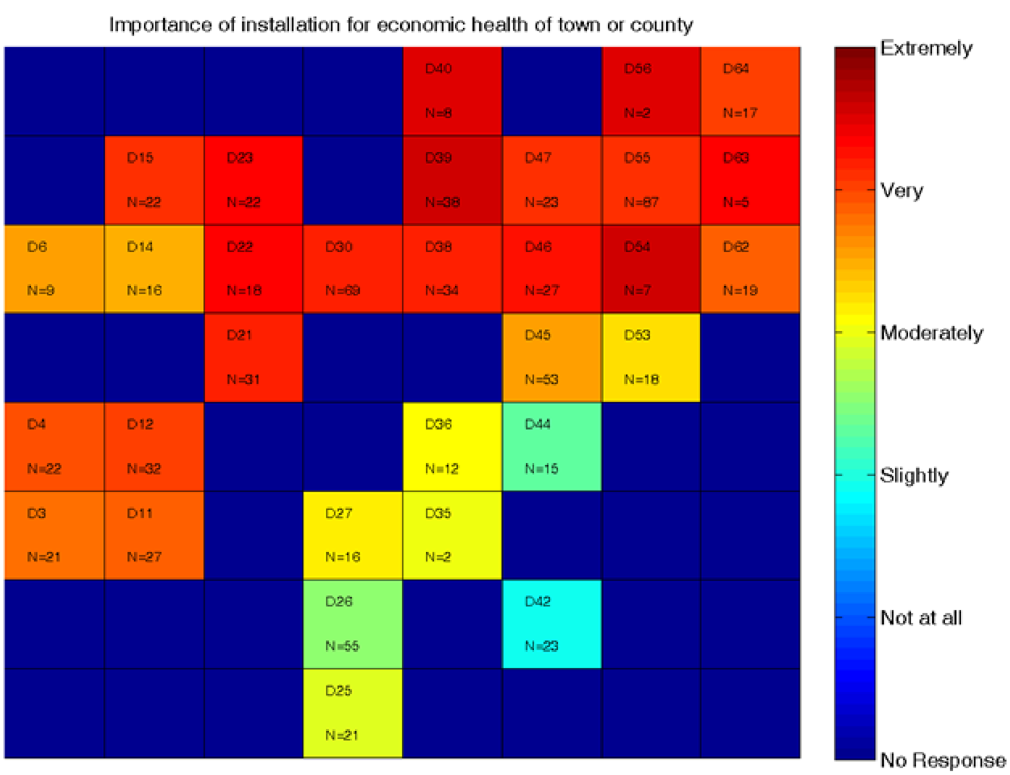


Figure 9. Spatial distribution of installation importance on the economic health of respondents' town or county.

In terms of blast noise, which is the focus of this study, the previous result can conversely be reported that approximately 74% of the respondents do not report hearing blast noise very often. It is possible this finding is a direct consequence of having such a large study area (approximately 4000 km^2). The majority of respondents report that blast noise does not interfere with conversation; however, 62% of respondents report that they have experienced vibration or rattle from blast noise. An examination of the spatial distribution of respondents reporting vibration or rattle (Figure 10) reveals that the residents living closest to the installation experience the most rattle.

3.3 Annoyance and habituation

In terms of the model developed in Section 3.1.2, there are two findings that are both statistically significant and practically significant; blast noise is the most annoying noise source, and self-reported ability to habituate to noise had an effect on the annoyance responses for the majority of noise sources (Figure 11). With exception of thunder, those respondents who report being able to habituate to noise (i.e., a habituation index of 5) are less annoyed than those who self-report ***not*** being able to habituate to noise (habituation index of 1). This finding is in congruence with the literature, which is summarized in Pater et al. (2007, p 9).

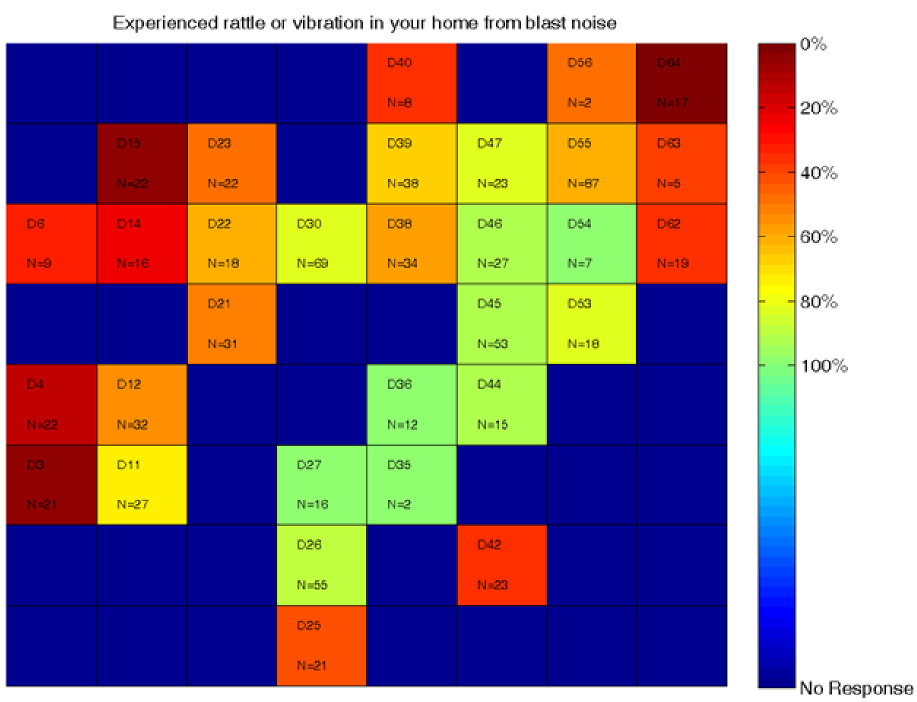


Figure 10. Percentage of respondents that have experienced rattle or vibration in their home from blast noise.

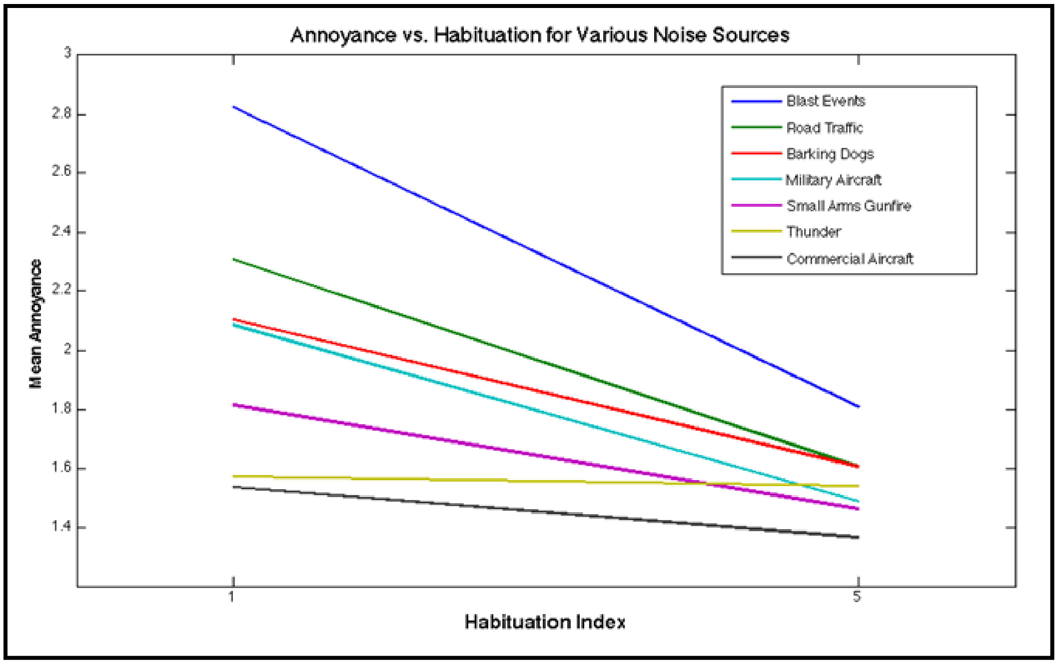


Figure 11. Mean annoyance response vs. self-reported ability to habituation for various noise sources.

Several other variables or effects in the final model were statistically significant, but after further examination were deemed as not practically significant. For example, it was found that respondents report more annoyance to all noise sources in terms of 12-month annoyance than 4-week annoyance. However, examination of the mean annoyances revealed that the annoyance ratings differed by less than 0.5. In addition to the differences in 12-month and 4-week annoyance finding the following list of statistically significant, though practically insignificant, items are noted here for completeness:

- As the number of reported items to rattle or vibrate increased, the mean annoyance increased.
- Respondents who were unaware of the installation and its noise before they moved into the neighborhood were, on average, more annoyed than those who were aware of the noise.
- Respondents who report that they considered moving because of noise were, on average, more annoyed than those who did not consider moving because of noise.
- Respondents who report their neighborhood is quiet report less annoyance than those who report that their neighborhood is noisy, or that it has an average amount of noise.

These findings will be re-examined in the GCS at Study Sites 2 and 3 to confirm their significance.

3.4 Dose-response results

Dose-response analyses were conducted to explore the relationship between typical stimulus noise metrics (dose) and community annoyance (response), though they were limited due to the imperfect methods that were used to classify triggered noise events as blasts on the noise monitors (i.e., sound level meters), and also due to the imperfect methods for extrapolating blast events from noise monitor locations to respondents' homes (see Section 3.1.2 for further discussion).

Two correlational analyses were carried out on the data: 12-month annoyance and metrics calculated from blast events extrapolated to respondents' homes within the past 12 months from the time of the survey, and correlation between 4-week annoyance and 4-week noise metrics. The data in Table 4 show that blast noise metrics are weakly correlated to annoyance; this is especially true for the 4-week results. For the 12-month results, it was found that the metrics: *Number of Blasts Above Unweighted Peak Level of 110 dB*, *Number of Blasts Above Unweighted Peak Level of 115 dB*, and *C-weighted Day-Night Level* have similar correlation coefficients (nominally 0.31). The finding that current blast noise metrics have poor correlation with community annoyance is not unexpected. The research team recently investigated the evolution of blast noise metrics over the past 50 years and the poor correlation is likely due to functional, technological, and sociopolitical constraints that underlie the current policies and guidelines. See Valente et al. (2011) for further discussion of this topic.

In additional to the correlational analyses and for historical reasons, the proportion of respondents highly annoyed (HA) was compared to the CDNL (Figure 12). The % HA is defined as the percentage of respondents that either respond *very* or *extremely annoyed* to question, "How bothered, annoyed, or disturbed are you to blast noise ..." "Very annoyed" and "extremely annoyed" correspond to a 4 or 5 respectively on the 5-point annoyance response scale.

Table 4. Correlation coefficients for stimulus and response metrics over 12-month and 4-week time periods.

	Number of Blasts Above Unweighted Peak 110 dB Z_{pk}	Number of Blasts Above Unweighted Peak 115 dB Z_{pk}	CDNL	Maximum Unweighted Peak Level (Z_{pk})	Maximum CSEL
12-month annoyance	0.32	0.31	0.31	0.19	0.18
4-week annoyance	0.18	0.12	−0.01*	0.16	0.15
*Not significant at $p < 0.05$					

Figure 12. Percent HA to blast noise vs. CDNL over the past 12 months.

In comparison to both the Land Use Zones[*] given in Army Regulation (AR) 200-1 (HQDA 2007) and criteria given in *Community Response to High-Energy Impulsive Sounds: An Assessment of the Field Since 1981* (CHABA 1996) — based on five impulse noise annoyance studies,[†] the current data show high annoyance at relatively low CDNL levels. For example, at a CDNL of 50 dB, the current study shows that approximately 20% of respondents were highly annoyed to blast noise whereas the CHABA curve predicts less than 5%. Similarly, at a CDNL of 65-75 dB, the Land Use Zones given in AR 200-1 correspond to “Zone II” areas where it is predicted that 15 to 39% of the community are likely to be HA and “not normally recommended” for residential land use (e.g., schools, housing, and medical facilities). The current findings show approximately 15 to 30% of the community highly annoyed to blast noise at a much lower CDNL range (i.e., 49-63 dB).

On the other hand, the current findings are within the range of %HA responses for the given by the data points (i.e., not the curve fit) in CHABA (1996); the %HA asymptotes to 25% HA at roughly a CDNL of 52 dB. The CHABA data points cover a range of 0 to 35% HA for CDNLs between 40 and 50 dB, a range of 0 to 50% HA for CDNLs between 50 and 60 dB, and a range of 5 to 35% HA for CDNLs between 60 and 70 dB.

[*] Note that this figure is reproduced and discussed in more detail in Nykaza et al. (2010a).

[†] This figure is also reproduced and discussed in Nykaza et al. (2010a).

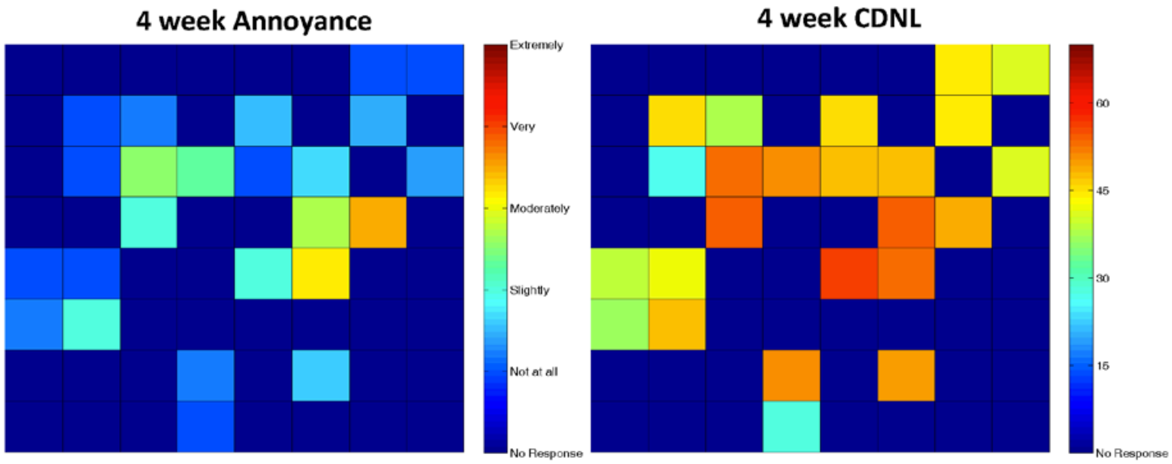
3.5 Discussion on the spatial and temporal variation of noise and annoyance

Perhaps one of the most important observations of this study is evidence to support one of the underlying hypotheses and motivations for the SERDP WP-1546 work package; both the stimulus (blast noise) and response (community annoyance) vary temporally and spatially. Figure 13 shows the mean 4-week annoyance to blast noise (left) and mean 4-week CDNL (right) for all respondents surveyed binned in to spatial regions (8km by 8km grid cells) for each month during the 9-month study.

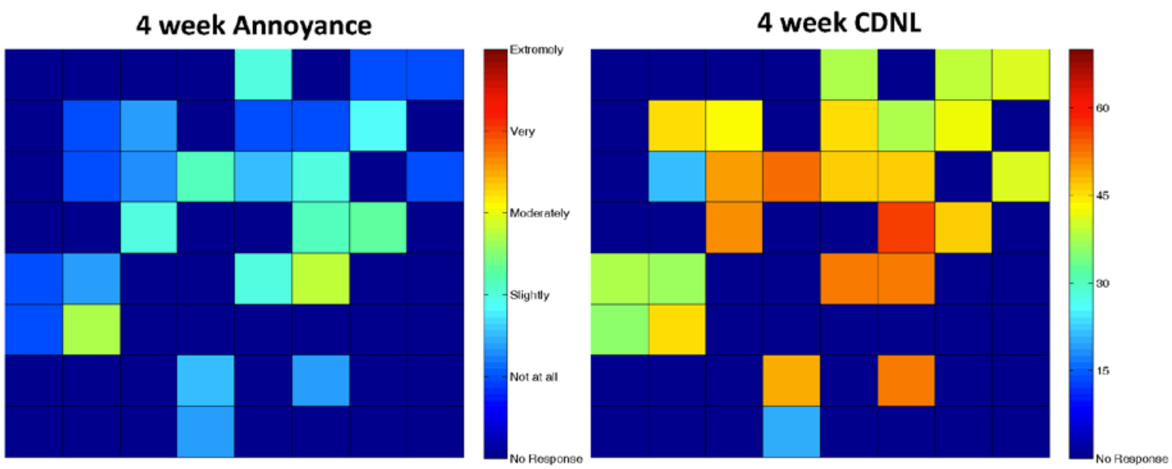
As with the other findings in this report that are rely on blast noise levels, confirmation of this hypothesis will also require support from Study Sites 2 and 3 given the relatively small number of respondents per region-month, which ranged from 1 to 24. However, if proven, this finding could have major implications on the way future studies of human response to any noise are conducted. Many studies of human response to noise are conducted under the assumption that both the stimulus and response do not change over time. As such, it is typical for an experimental data collection to be comprised of a single survey at one point in time, and to compare that snapshot of the community response to stimulus measures that are often predicted or measured at time periods that differ from the collection of the response data. The Appendix Pater et al. (2007) discusses this topic in more detail.

3.6 Current results compared with other WP-1546 studies

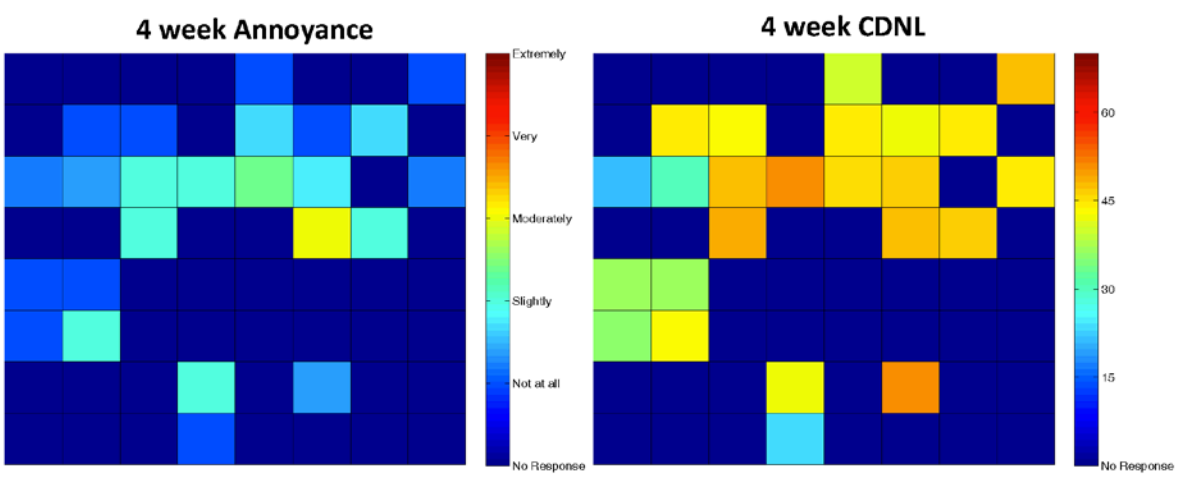
The results found in this latest effort mirror some of the findings in the PI (Nykaza et al. 2010b) and the Complaint Survey Protocol (CS) (Nykaza et al. 2010a, 2011). The PI study was conducted at three different military installations, with one of these locations being the same as the current study. Although the PI study was a smaller scale effort in terms of the number of residents interviewed and more qualitative approach in comparison to the other WP-1546 protocols, several findings were in agreement with the current GCS findings. For example, both efforts indicate that the majority of respondents are aware of the installation and the noise it produces, like their community and neighborhood, and associate rattle or vibration with blast noise.



Month 1

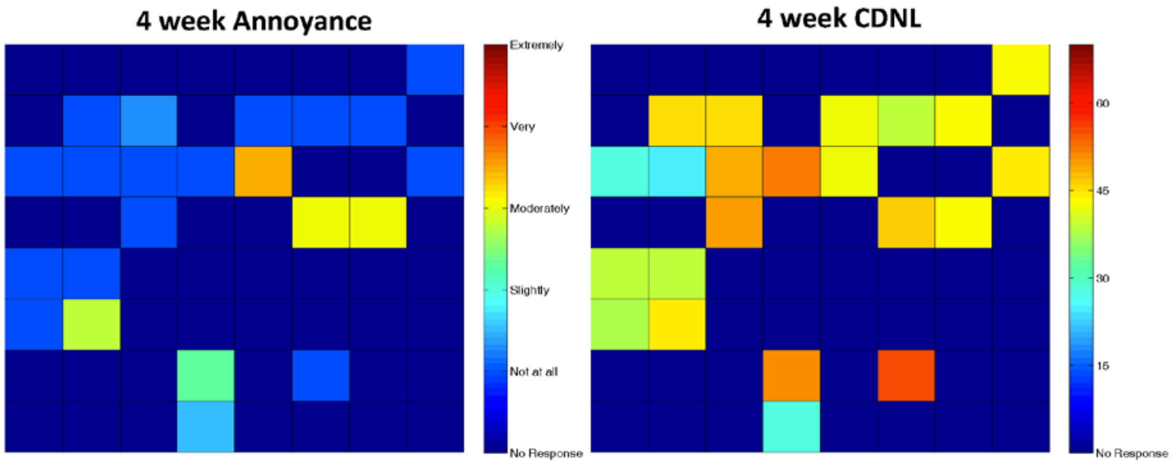


Month 2

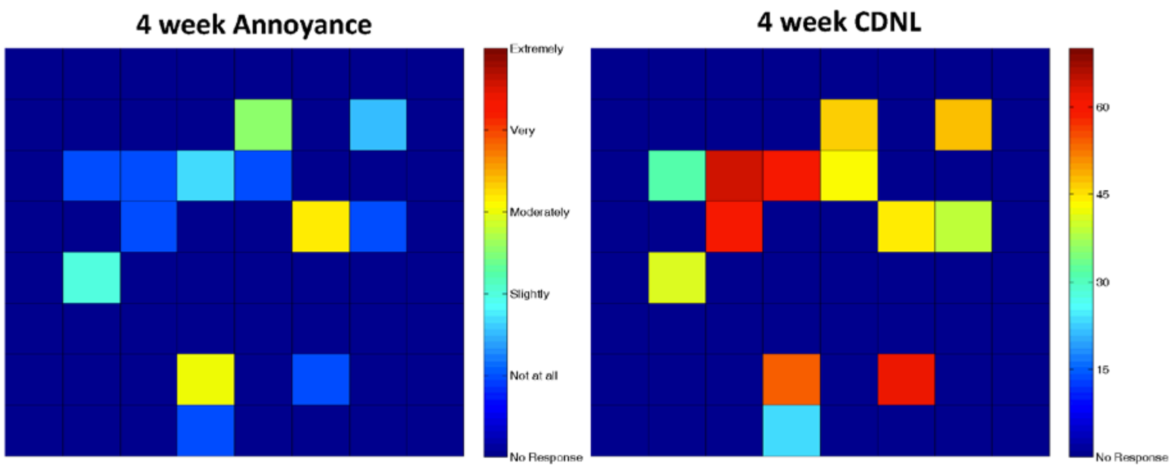


Month 3

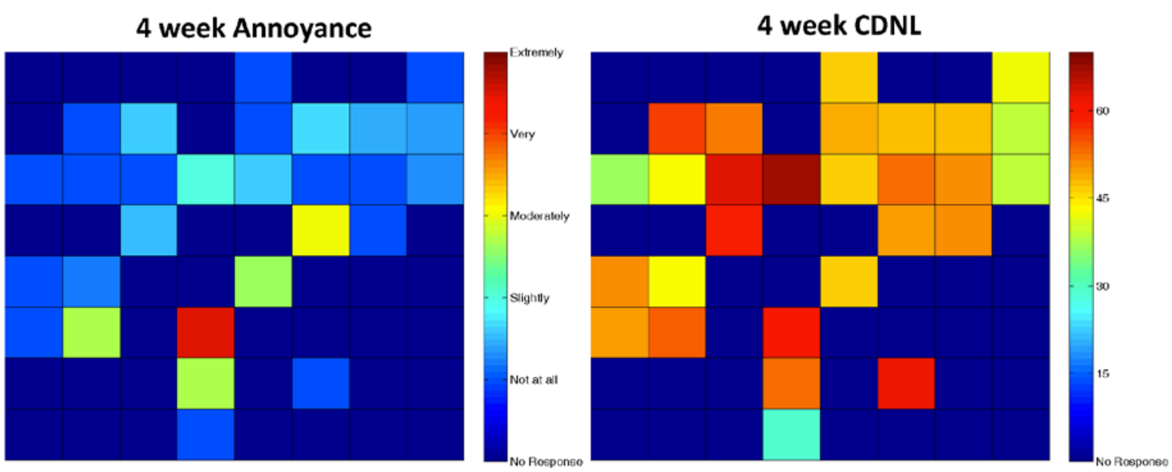
Figure 13. Spatial and temporal variation of stimulus (blast noise) and response (annoyance) over study months 1 through 9.



Month 4

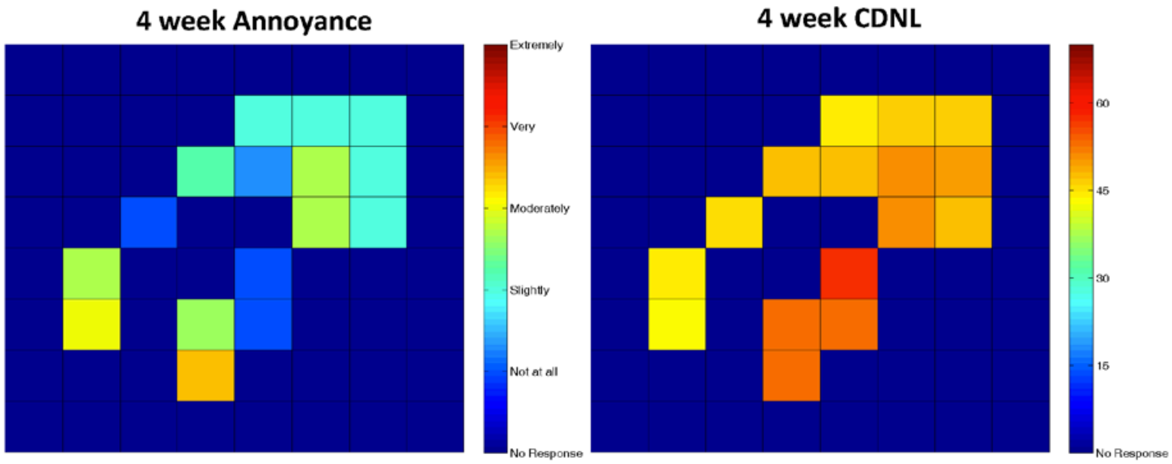


Month 5

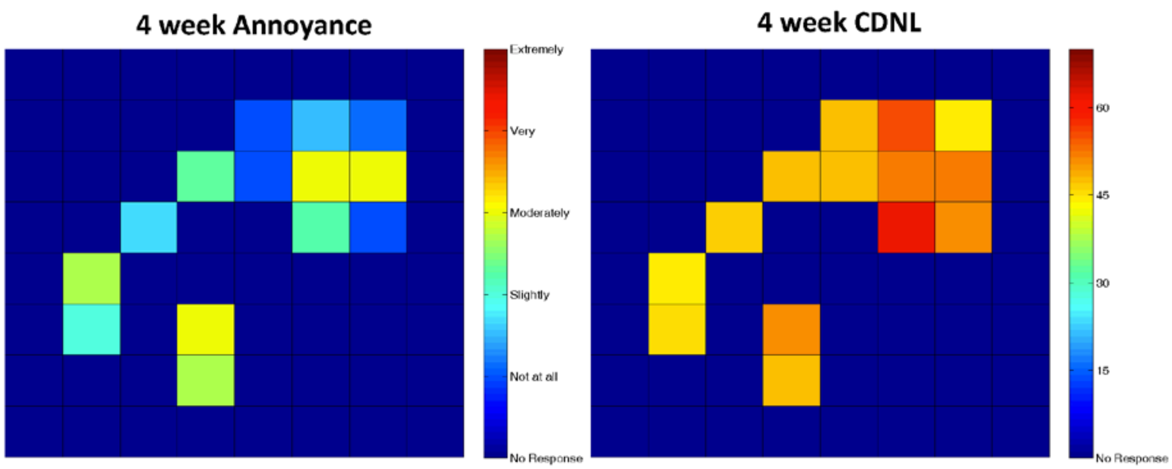


Month 6

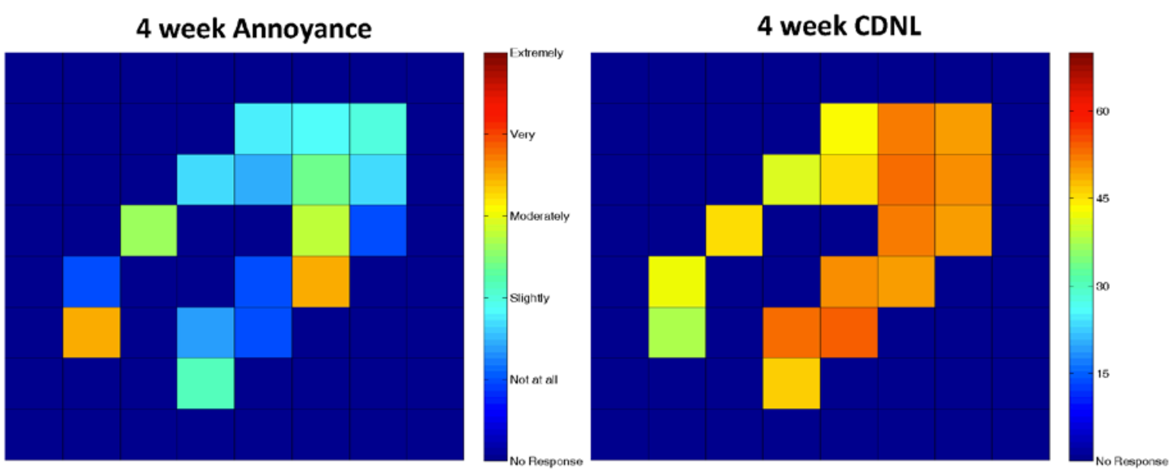
Figure 13. (Cont'd).



Month 7



Month 8



Month 9

Figure 13. (Cont'd).

The CS was conducted between September 2008 and March 2009, at the same site as the current effort though much fewer surveys were conducted and the CS data were gathered over a much smaller geographical area. Similar to the PI findings, the majority of respondents report that their neighborhood is a good (33% CS, 34% GCS) or excellent (51% CS, 45% GCS) place to live and that their neighborhood is either quiet (68% CS, 53% GCS) or of average noisiness (20% CS, 34% GCS). Blast noise or military noise was found to be the most annoying noise source of those sources that were surveyed, and of the respondents that mention rattle or vibration (87% CS, 62% GCS), 78% of CS respondents and 57% of GCS respondents mentioned that their windows rattled.

3.7 Discussion on potential non-response bias

The overall response rate for the GCS at Installation 1 was relatively low. Specifically, interviews were completed with 16.7% of the eligible sample. This figure is calculated as the number of completed interviews divided by the total number of households, excluding businesses and confirmed "out of area," i.e.:

$$\text{Response Rate} = \text{Complete}/\text{Sample N} - (\text{Business} + \text{Out of Area}) \qquad \text{Eq. 2}$$

This calculation follows guidelines published by the American Association for Public Opinion Research (AAPOR), which is a professional association that establishes standards, "best practice" guidelines, and a code of ethics for professional survey researchers and research firms (AAPOR 2000).

A low response rate for this survey raises concerns about the representativeness of the findings and the potential for non-response bias. Intuitively, if interviews were completed with roughly 20% of the eligible sample, it seems reasonable to assume that relatively modest differences among the (unobserved) 80% of the eligible sample would produce quite different results. However, a low response rate does not, in and of itself, mean there is non-response bias. Survey estimates are biased due to non-response when sampled units (e.g., individuals) who do not participate in a survey are systematically different from those who do participate *and those differences are correlated with the outcome of interest*. As a result, assessing the effect of non-response on survey data entails theoretical and substantive considerations, not just mathematical or statistical calculations. Researchers must ask questions such as:

- Why are some individuals not participating in the survey?
- How are they different from those who did participate?
- Can we reasonably expect those differences to be related to key measures of interest?

(Note that Krecker [2011] discusses non-response in the GCSs and the effects of non-response on survey estimates at greater length.)

Two factors are important to note when reviewing the response rate for the GCS. First, the response rate calculation uses a conservative method. The proportion of households that could be defined as "ineligible" or not part of the sample population were not estimated because the housing unit(s) were unoccupied or no household member was usually home during daytime hours. Instead, this work chose the more conservative calculation that retains all unconfirmed households in the denominator and assumes they are part of the survey population.

Second, it is important to consider the sources of non-response and determine whether the sources may be systematically related to the outcome of interest (Groves 2006). The data in Table 5 indicate that the non-response in the GCS stems largely from the inability to contact sampled households by telephone. Specifically, almost one-half of the sampled households could not be contacted because researchers were unable to obtain a valid telephone number. Refusal to participate was the second largest source of non-response (10%). About 5% of the sample reached the maximum number of call attempts without completing the survey. That is, although researchers obtained a valid, or at least working, telephone number for these households, they were unable to complete the interview before reaching the maximum number of attempts specified by the study protocol. Other sources of non-response account for less than 1% of non-response (e.g., health impairments, language barrier).

Non-contact means "households that could not be reached by (a land line) telephone." The survey was conducted only by telephone, and the sample frame lacked telephone numbers or high quality contact information. Telephone numbers were obtained from public sources through reverse look-up procedures (e.g., white pages, Internet databases that are accessible to the public for no fee). Households with incomplete addresses (e.g., missing apartment numbers), with unlisted telephone numbers, with only mobile telephone coverage, or with new or recently changed telephone numbers cannot be matched to public databases.

Table 5. GCS at Installation 1: Final Sample Dispositions.

Disposition	Total	Percent
Original Sample	**4761**	
Business number	77	
Ineligible – Address not confirmed	72	
Eligible Sample	**4612**	
Completed interview	771	16.7
Partial interview	16	0.3
Refusal	478	10.4
Unavailable for duration	11	0.2
Incapable/incoherent	20	0.4
Language barrier/non-English	11	0.2
Called out – maximum attempts	210	4.6
Non-contact		0.0
Non-working number	1447	31.4
Disconnected number	744	16.1
Fax/data line	40	0.9
Active sample	864	18.7
Response Rate	**16.7**	

The experience here of matching telephone numbers to the GCS sample was similar to that reported by other researchers. In an analysis of different databases and matching strategies, Amaya, Skalland, and Wooten (2010) found that match rates for address-based samples can average 50% of all sample points and are often less than 20% of multi-family dwellings. Moreover, the impact of mobile-telephone-only households can be significant. In Installation 1's state, an estimated 18.4% of households rely solely on mobile telephone coverage, a figure that is below the national average of 25% (Blumberg et al. 2011). An additional 21.2% of households in the state are "mostly wireless."

The refusal rate is somewhat high but not unusual for surveys of this length (over 20 minutes on average) or design. For example, we were unable to use two elements of survey design that generally increase survey participation. These include personalized, advance notification letters that explain the purpose of the study and how the results will be used (De Leeuw et al. 2007), and a monetary or non-monetary incentive (Heberlein and Baumgartner 1978; Singer et al. 1999; Singer, Van Hoewyk, and Maher 2000).

Further efforts are underway to assess non-response in the GCS at Installation 1 and to determine whether survey estimates are biased. Specifically, a small, follow-up effort was conducted with personal interviewers who administered the survey to households that could not be contacted by telephone. This effort focused on a specific geographic area where data from noise monitor were available, and a subsample was drawn from households from the original study that had never been contacted. Analysis of these data will help determine whether survey estimates from the "original" data-collection efforts are biased because households that cannot be reached by telephone consistently react to blast noise differently.

Data from the in-person interviews are still being processed. However, our field experience yielded two valuable lessons. First, sample members can be successfully approached by in-person interviewers, even without an advance notification letter or other prior contact. Interviews were completed with 30% of households that were attempted (53 completed interviews of 182 households attempted). This is a relatively high response given that the in-person effort was brief (5 days) and interviewers were not able to make follow-up visits if no one was home at the first attempt.

Second, an in-person effort is essential to identify ineligible sample units. Interviewers identified 47 addresses—an entire housing subdivision—where the street addresses had been established but the housing units were not yet constructed. These cases are not part of the eligible sample and should be removed from the calculation of the response rate. It was confirmed after the in-person effort that there is no reliable way to identify unconstructed homes or vacant lots from the electronic databases that provide the sample frame or append the telephone numbers.

4 Summary and Conclusions

This work constructed and administered the GCS at a military installation (Site 1) to determine how blast noise levels affect general community annoyance and how the community reaction changes over time in response to a dynamic blast noise environment. The results of the cross-sectional GCS performed at Site 1 follow.

The majority of respondents had generally positive things to say about their neighborhood. Most respondents report that their neighborhood is a good or excellent place to live and that their general noise environment is either quiet or about average. In regards to respondents' awareness of the installation, most report that they were aware of the installation noise before they moved into the neighborhood, and that the installation is important for the economic health of the area.

On the other hand, blast noise was the most annoying source around Installation 1. Blast noise was also the second most frequently heard noise source of the eight noise sources surveyed in this study; however, 74% of respondents report that they do not hear blast events that often, which may be a consequence of having such a large study area (64 x 64 km).

In terms of factors that contribute to annoyance, it was found that speech interference did not contribute to annoyance, but habituation and vibration/rattle did contribute to annoyance. Respondents that self-report being able to habituate to noise had less overall annoyance than those who self-report not being able to habituate to noise. In addition to habituation, 62% of respondents report that they have experienced vibration or rattle from blast noise. When the respondents were divided into geographical regions, it was found that those who experience rattle or vibration live in areas approximately 15–20 km from the perimeter of the installation.

In terms of traditional blast noise assessment metrics (e.g., CDNL and Zpk), blast noise was weakly correlated with annoyance, and there was high annoyance at relatively low CDNL levels. Although there were a large number of events over a Zpk of 115 and 130 dB, the yearly average metrics (i.e., CDNL) were quite low. These findings are likely attributed to the sporadic nature of blast events distributed throughout a year, and support the current hypothesis that current or traditional blast noise assessment

metrics do not properly account for the number and level nor the spatial and temporal variation of blast events.

Lastly, it is anticipated that the upcoming GCS data collections and analyses will remedy some of the shortcomings identified with the current study. Future GCS studies will be conducted over smaller study regions (e.g., three 16 km^2 regions rather than one 4096 km^2 region), will use 16-bit data recorders rather than sound level meters, and will employ follow-up in-person data-collection procedures to avoid low response rates. Findings from this effort that were found to be statistically significant, but not practically significant, will be re-examined. In addition, in situ studies to identify response thresholds to important factors (e.g., vibration, loudness, etc.) will inform future GCS analyses and findings.

Acronyms and Abbreviations

Term	Definition
AAPOR	American Association for Public Opinion Research
ADNL	A-weighted Day-Night Level
ANCOVA	Analysis of Covariance
ANSI	American National Standards Institute
AR	Army Regulation
CATI	Computer-Assisted-Telephone-Interviewing
CDNL	C-weighted yearly average Day-Night Level
CERL	Construction Engineering Research Laboratory
CHABA	[National Research Council] Committee on Hearing, Bioacoustics, and Biomechanics
CLMAX	maximum exponentially fast-averaged C-weighted sound pressure level
CS	Complaint Survey Protocol
CSEL	C-weighted Sound Exposure Level
DDESB	Department of Defense Explosives Safety Board
DoD	US Department of Defense
ERDC	Engineer Research and Development Center
GAO	US Government Accountability Office
GCS	General Community Survey
HA	Highly Annoyed
HQDA	Headquarters, Department of the Army
ICBEN	International Commission on the Biological Effects of Noise
ID	Identification
IRB	[Pennsylvania State University Office of Research Protections] Institutional Review Board
NSN	National Supply Number
NSWC	Naval Surface Warfare Center
OMB	Office of Management and Budget
PI	Personal Interview Protocol
SAR	Same as Report
SAS®	Statistical Analysis Software
SERDP	Strategic Environmental Research and Development Program
SF	standard form
SR	Special Report
TR	Technical Report
US	United States
UTM	Universal Transverse Mercator
VIF	variance inflation factor
WWW	World Wide Web
ZPk	unweighted peak level

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Appendix A: General Community Survey Instrument with Answer Distributions

Part A: General Community Questions

The following questions in Part A are intended for use in the GCS at all installations. The specific questions and the order may vary between installations. The specific questions to be included at each installation will be determined in consultation with representatives from each installation.

INTERVIEW ID: _____ ______
(house) (person)

INTERVIEW DATE: ____/____/_____
(mo)/(day)/(year)

INTERVIEW TIME: ____:____ a.m. or p.m. (Note: survey is to be conducted between 9 a.m. and 8 p.m.)

INTERVIEWER ID: ____

OMB No.: 0710-0015
OMB Expires: 31 May 2011

Agency Disclosure Notice

The public report burden for this information collection is estimated to average 30–45 minutes for the interview, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to:

Department of Defense
Washington Headquarters Services
Executive Services Directorate
Information Management Division (0710-0015)
1155 Defense Pentagon, Washington DC, 20301-1155

Office of Information and Regulatory Affairs
Office of Management and Budget
ATTN: Desk Officer for US Army Corps of Engineers
Washington, DC 20503.

Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR SURVEY TO THE ABOVE ADDRESSES.**

Introduction (Implied Consent)

Good morning/afternoon/evening. My name is ______ and I am calling on behalf of the US Army Corps of Engineers and Pennsylvania State University. We are conducting a research study about residents' attitudes about their community. It is important that we talk to different types of people and your household is one of a small number randomly selected from this community.

To make sure that our study represents people who live in your community and are able to answer our questions, I need to speak with an adult that lives at this residence. Would that be you?

1 YES (repeat intro)
2 NO (THANK AND EXIT)

I would like to verify your location. Do you live at [address]?

1 YES (CONTINUE)
2 NO (THANK AND EXIT)

CONF: Before we begin, I need to tell you a few things.

Your response is voluntary, you can quit at any time, and you may choose not to answer certain questions. The results of this study will be summarized so that the answers you provide cannot be associated with you or anyone in your household. The length of the interview varies from person to person, but most interviews last about 30 minutes. You must be 18 years of age or older to consent to take part in this research study. Responding to the survey questions implies your consent to participate in the survey. If you have any questions about the survey, you can contact Kathleen K. Hodgdon at (814) 865-2447 or (kkh2@psu.edu) at the Pennsylvania State University or Peg Krecker at (608) 443-2700 at PA Consulting Group

Do you have any questions before we begin?

Household Size and General Neighborhood Characteristics

A1. First, including yourself, how many people live in your household?

1		21.8
2		44.5
3		15.4
4		10.8
5		4.0
6		1.8
7		0.8
8		0.1
8	Don't know	0.3
9	Refused	0.5

A2. Do any children under age 6 live in your household?

1	Yes	9.9
2	No	89.9
9	Don't know	0.3

A3. Including yourself, how many adults age 18 or older live in your household?

1		25.6
2		57.6
3		12.6
4		3.2
5		0.6
8		0.1
9	Refused	0.3

A4. Have you heard about this survey before my call today?

1	Yes	11.7
2	No	88.1
8	Refused	0.3

A5. How would you rate your neighborhood overall as a place to live? Would you say terrible, poor, average, good, or excellent?

1	Terrible	0.3
2	Poor	2.7
3	Average	17.8
4	Good	34.2
5	Excellent	44.5
8	Don't know	0.5

A6. What are some of the things you LIKE most about living in your neighborhood?

____

A7. What are some of the things you DISLIKE most about living in your neighborhood?

____

A8. While we are interested in all neighborhood conditions, we are particularly interested in the various kinds of noises that people hear in this area. Do you think your neighborhood is quiet or noisy or about average?

1	Quiet	52.9
2	Average	34.0
3	Noisy	10.9
8	Don't know	2.1
9	Refused	0.1

A9. Can you tell me more about why you feel that way?

____

Experience with Common Neighborhood Noises

I am going to read a list of neighborhood noises. During the **last 12 months** when you were at home, how much did noise from each of these sources bother, disturb, or annoy you?

B1. Barking dogs

1	Not at all	59.3
2	Slightly	21.8
3	Moderately	12.7
4	Very	2.9
5	Extremely	3.4

B2. Thunder

1	Not at all	67.3
2	Slightly	18.4
3	Moderately	11.2
4	Very	1.7
5	Extremely	1.0
8	Don't know	0.3
9	Refused	0.1

B3. Street traffic

1	Not at all	57.3
2	Slightly	21.1
3	Moderately	13.6
4	Very	3.9
5	Extremely	4.0

B4. Commercial aircraft

1	Not at all	79.4
2	Slightly	14.5
3	Moderately	4.7
4	Very	0.5
5	Extremely	0.8
8	Don't know	0.1

B5. Military aircraft, including military helicopters, jets, and prop planes.

1	Not at all	63.7
2	Slightly	22.2
3	Moderately	8.9
4	Very	2.9
5	Extremely	1.8
8	Don't know	0.5

B6. Military ground vehicles

1	Not at all	96.6
2	Slightly	2.1
3	Moderately	0.9
4	Very	0.4

B7. Small military gunfire

11	Not at all	75.2
2	Slightly	11.0
3	Moderately	7.8
4	Very	2.6
5	Extremely	2.6
8	Don't know	0.8

B8. Large military guns, bombs, or explosions

1	Not at all	54.9
2	Slightly	17.4
3	Moderately	12.8
4	Very	6.0
5	Extremely	8.7
8	Don’t know	0.1
9	Refused	0.1

I am going to read the same list of neighborhood noises but now I’d like you to think about the last 4 weeks. During the last **4 weeks** when you were at home, how much did noise from each of these sources bother, disturb, or annoy you?

B9. Barking dogs

1	Not at all	69.5
2	Slightly	17.8
3	Moderately	8.3
4	Very	1.4
5	Extremely	2.9
9	Refused	0.1

B10. Thunder

1	Not at all	79.4
2	Slightly	12.5
3	Moderately	5.4
4	Very	2.1
5	Extremely	0.5
8	Don’t know	0.1

B11. Street traffic

1	Not at all	65.8
2	Slightly	17.0
3	Moderately	10.5
4	Very	3.4
5	Extremely	3.4

B12. Commercial aircraft

1	Not at all	86.5
2	Slightly	9.6
3	Moderately	3.2
4	Very	0.3
5	Extremely	0.4

B13. Military aircraft, including military helicopters, jets, and prop planes.

1	Not at all	75.2
2	Slightly	14.7
3	Moderately	6.9
4	Very	1.6
5	Extremely	1.2
8	Don’t know	0.5

B14. Military ground vehicles

1	Not at all	97.4
2	Slightly	1.4
3	Moderately	0.6
4	Very	0.1
5	Extremely	0.1
8	Don’t know	0.3

B15. Small military gunfire

1	Not at all	83.8
2	Slightly	7.9
3	Moderately	5.2
4	Very	0.9
5	Extremely	1.8
8	Don’t know	0.4

B16. Large military guns, bombs, or explosions

1	Not at all	64.1
2	Slightly	13.9
3	Moderately	10.2
4	Very	4.0
5	Extremely	7.3
8	Don’t know	0.5

During the last 4 weeks when you were at home, how often did you hear each of the following noises – not at all, only occasionally, moderately often, frequently, or very often?

B17. Street traffic

1	Not at all	33.9
2	Only occasionally	33.9
3	Moderately often	17.4
4	Frequently	5.8
5	Very often	8.8
8	Don't know	0.1
9	Refused	0.1

B18. Commercial aircraft

1	Not at all	60.6
2	Only occasionally	28.9
3	Moderately often	6.9
4	Frequently	1.9
5	Very often	0.8
8	Don't know	0.9

B19. Military aircraft, including military helicopters, jets, and prop planes

1	Not at all	44.2
2	Only occasionally	38.3
3	Moderately often	10.4
4	Frequently	3.5
5	Very often	1.8
8	Don't know	1.8

B20. Military ground vehicles

1	Not at all	94.3
2	Only occasionally	4.2
3	Moderately often	0.6
4	Frequently	0.3
5	Very often	0.1
8	Don't know	0.5

B21. Small military gunfire

1	Not at all	75.1
2	Only occasionally	13.9
3	Moderately often	6.0
4	Frequently	2.3
5	Very often	1.9
8	Don't know	0.8

B22. Large military guns, bombs, or explosions

1	Not at all	44.6
2	Only occasionally	28.0
3	Moderately often	14.4
4	Frequently	5.8
5	Very often	5.7
8	Don't know	1.4

B23. Is there a particular time of day when noises from your neighborhood are most disturbing?

1	Yes	46.0
2	No	52.8
8	Don't Know	1.2

B24. [If B23=1] What times of day are the noises from your neighborhood most disturbing?

___:___ AM/PM TO ___:___ AM/PM
___:___ AM/PM TO ___:___ AM/PM
___:___ AM/PM TO ___:___ AM/PM

Rattle and Vibration

The next questions are about vibration and rattles.

C1. Vibration is a motion. The motion may be seen, felt or heard. Rattle is a type of noise that can occur when objects move due to a vibration. Have you ever experienced rattle or vibration in your home from large military guns, bombs or explosions?

1	Yes	62.0
2	No (Skip to C7)	37.2
8	Don't know (Skip to C7)	0.8

C2. What structures in your home rattled or vibrated?

Windows		
0	Not mentioned	25.6
1	Mentioned	34.6
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Walls		
0	Not mentioned	51.0
1	Mentioned	9.2
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Shelves		
0	Not mentioned	57.8
1	Mentioned	2.3
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

China		
0	Not mentioned	54.5
1	Mentioned	5.7
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Small decorative items		
0	Not mentioned	52.0
1	Mentioned	8.2
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1
Floors		
0	Not mentioned	56.2
1	Mentioned	4.0
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1
Garage door		
0	Not mentioned	59.8
1	Mentioned	0.4
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1
Other		
0	Not mentioned	51.9
1	Mentioned	8.3
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1
Entire house		
0	Not mentioned	42.2
1	Mentioned	18.0
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1
Pictures		
0	Not mentioned	52.7
1	Mentioned	7.5
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Chandelier		
0	Not mentioned	59.3
1	Mentioned	0.9
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Doors		
0	Not mentioned	57.6
1	Mentioned	2.6
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

Lights		
0	Not mentioned	59.5
1	Mentioned	0.6
7	Not applicable	38.0
8	Don't know	1.7
9	Refused	0.1

C3. During the last 4 weeks**, has the noise or rattle from military gunfire, bombs or explosions interfered with your ability to talk with others or hear conversations INSIDE your home?**

1	Yes	3.6
2	No	58.1
7	Not applicable	38.0
8	Don't know	0.3

C4. During the last 4 weeks**, has the noise or rattle from military gunfire, bombs or explosions interfered with your ability to talk with others or hear conversations OUTSIDE your home?**

1	Yes	5.6
2	No	56.0
7	Not applicable	38.0
8	Don't know	0.4

C5. During the last 4 weeks**, has noise or rattle from military gunfire, bombs or explosions disturbed or disrupted your other activities INSIDE your home?**

1	Yes	6.5
2	No	55.4
7	Not applicable	38.0
8	Don't know	0.1

C6. During the last 4 weeks, has noise or rattle from military gunfire, bombs or explosions disturbed or disrupted your other activities OUTSIDE your home?

1	Yes	3.6
2	No	58.2
7	Not applicable	38.0
8	Don't know	0.1

C7. Since you have been living at your current address, have you ever been awakened by noises coming from outside your home?

1	Yes	59.0
2	No	39.9
8	Don't know	1.0

C8. What was the source of the noise that awakened you?

____

C9. During the last 12 months, how often do you recall having been awakened by noise from [C8]?

1	Not at all	6.0
2	Only occasionally	38.8
3	Moderately often	8.7
4	Frequently	3.5
5	Very often	2.1
7	Not applicable	41.0

C10. Has this happened to you in the last 4 weeks?

1	Yes	23.7
2	No	34.1
7	Not applicable	41.0
8	Don't know	1.2

Thinking about the last 12 months, when you are at home, how often does noise in your neighborhood affect you in the following ways.

D1. First, how often does the noise (in your neighborhood) startle you or make you jump? Would you say not at all, only occasionally, moderately often, frequently, or very often?

1	Not at all	57.2
2	Only occasionally	31.9
3	Moderately often	6.1
4	Frequently	2.3
5	Very often	2.2
8	Don't know	0.1
9	Refused	0.1

D2. How often does the noise frighten you?

1	Not at all	74.1
2	Only occasionally	19.7
3	Moderately often	2.6
4	Frequently	2.1
5	Very often	1.0
8	Don't know	0.5

D3. How often does the noise cause you to feel irritable or edgy?

1	Not at all	71.2
2	Only occasionally	18.5
3	Moderately often	5.7
4	Frequently	2.2
5	Very often	2.3

D4. How often does the noise make you become tense or nervous?

1	Not at all	79.5
2	Only occasionally	13.6
3	Moderately often	3.8
4	Frequently	1.9
5	Very often	0.9
8	Don't know	0.3

I'm going to read several statements. For each statement, please tell me if you strongly disagree, moderately disagree, neither agree nor disagree, moderately agree or strongly agree.

E1. I believe that people have a hard time getting used to noise.

1	Strongly disagree	8.2
2	Moderately disagree	19.3
3	Neither agree nor disagree	10.2
4	Moderately agree	43.1
5	Strongly agree	13.5
8	Don't know	5.7

E2. I believe that people get used to road traffic noise.

1	Strongly disagree	5.4
2	Moderately disagree	6.6
3	Neither agree nor disagree	3.1
4	Moderately agree	52.7
5	Strongly agree	29.7
8	Don’t know	2.3
9	Refused	0.1

E3. I believe that with time most people adapt to noise.

1	Strongly disagree	4.2
2	Moderately disagree	6.5
3	Neither agree nor disagree	3.2
4	Moderately agree	47.3
5	Strongly agree	36.4
8	Don’t know	2.2
9	Refused	0.1

E4. I believe that with time I can adapt to noise.

1	Strongly disagree	9.2
2	Moderately disagree	6.6
3	Neither agree nor disagree	2.7
4	Moderately agree	42.4
5	Strongly agree	37.1
8	Don’t know	1.4
9	Refused	0.5

E5. I believe that with time I can get used to even the loudest noise.

1	Strongly disagree	40.3
2	Moderately disagree	16.3
3	Neither agree nor disagree	2.1
4	Moderately agree	22.6
5	Strongly agree	17.0
8	Don’t know	1.6
9	Refused	0.1

Part B: Installation-Specific Questions

These next questions are about [NAME OF INSTALLATION] and how you feel about living close to it.

F1. Do any members of your household currently work for the military installation?

1	Yes	7.1
2	No	92.6
8	Don't know	0.3

F2. Have any members of your household ever served in the Armed Services?

1	Yes	52.8
2	No	47.0
8	Don't know	0.3

F3. Do any members of your household currently receive retirement or disability income as a result of military or civilian service in the Department of Defense?

1	Yes	52.8
2	No	47.0
8	Don't know	0.3

F4. How would you rate the importance of [NAME OF INSTALLATION] for the economic health of your town and county? Please select from one of the following [READ RESPONSES]

1	Not at all important	7.9
2	Slightly important	7.3
3	Moderately important	17.6
4	Very important	27.8
5	Extremely important	33.1
6	Other *(SPECIFY)*	1.6
8	Don't know	4.5
9	Refused	0.3

F5. How would you rate the importance of Federal funding to your local school district from the [NAME OF INSTALLATION]?

1	Not at all important	9.2
2	Slightly important	4.5
3	Moderately important	13.9
4	Very important	24.9
5	Extremely important	23.2
6	Other	3.8
8	Don't know	20.0
9	Refused	0.5

The next questions ask about the time you personally are at home. Remember that this information will be kept confidential and will only be used to help us better understand your answers to the questions. The times that you provide will allow us to understand your answers with regard to likely noise sources in the community.

G1. On a typical weekday, about what time do you usually wake up?

____:____ AM or PM
8 Don't know
9 Refused

G2. On a typical weekday, about what time do you usually fall asleep?

____:____ AM or PM
8 Don't know
9 Refused

G3. On a typical weekday, how many hours are you usually at home in the morning between the hours of 6 AM and 8 AM? [IF NEEDED, REMIND THAT THIS IS A 2-HOUR PERIOD]

____ Hours
8 Don't know
9 Refused

G4. On a typical weekday, how many hours are you at home during the day? That is between the hours of 8 AM and 6 PM? [IF NEEDED, REMIND THAT THIS IS A 10-HOUR PERIOD]

____ Hours
8 Don't know
9 Refused

G5. On a typical weekday, how many hours are you at home in the evening between the hours of 6 PM and 10 PM? [IF NEEDED, REMIND THAT THIS IS A 4-HOUR PERIOD]

____ Hours
8 Don't know
9 Refused

G6. On a typical weekday, how many hours are you at home during sleeping hours? That is between the hours of 10 PM and 6 AM? [IF NEEDED, REMIND THAT THIS IS AN 8-HOUR PERIOD]

____ Hours
8 Don't know
9 Refused

H1. How long have you lived at your current address? [READ LIST]

1	Less than 1 year	2.1
2	1–5 years	22.8
3	6–10 years	16.7
4	More than 10 years	58.2
8	Don't know	0.1

H2. Do you rent or own your home?

1	Rent	12.3
2	Own	86.3
3	Other	1.0
8	Don't know	0.1
9	Refused	0.3

H3. About how old is your home?

1	0–10 years	16.6
2	11–20 years	11.9
3	21–30 years	13.7
4	31–40 years	14.9
5	More than 40 years	39.7
8	Don't know	3.1

H4. How old are most of the windows in your home?

[Interviewer prompt if necessary: Are they the original or replacement windows?]

1	0–10 years	47.7
2	11–20 years	20.6
3	21–30 years	9.3
4	31–40 years	5.3
5	More than 40 years	9.3
6	Other	3.0
8	Don't know	4.5
9	Refused	0.1

H5. Are most of the windows in your home single-frame, double-frame, single-paned, or double-paned?

1	Single-frame	4.9
2	Double-frame	5.3
3	Single-paned	12.1
4	Double-paned (Insulated or storm windows in place)	67.4
5	Other	5.6
8	Don't know	4.4
9	Refused	0.3

H6. What is the type of construction of your home?

1	Stone	1.7
2	Brick	15.2
3	Aluminum siding	9.2
4	Vinyl siding	26.8
5	Stucco	1.6
6	Wood frame	22.6
7	Modular unit	1.4
8	Concrete block	2.6
9	Other	14.1
10	Brick and vinyl	3.5
8	Don't know	1.0
9	Refused	0.3

H7. Which of the following best describes the type of home in which you live? [READ LIST]

1	Single-family detached [no common walls]	82.2
2	Single-family attached [at least one common wall with the surrounding dwellings]	7.1
3	Multi-family home [more than one common wall]	7.7
4	A mobile home or trailer	1.6
5	Other	1.2
8	Don't know	0.1
9	Refused	0.1

H8. (If H7=1) What is the style of the house?

1	Two story	8.6
2	Two story with basement	24.5
3	Ranch on concrete slab	7.3
4	Ranch with basement	19.6
5	Bi-level	5.7
6	Other style *(SPECIFY)*	12.5
7	Ranch on blocks	3.5
7	Not applicable	17.8
8	Don't know	0.4
9	Refused	0.3

H9. Have you ever considered moving to another community because of the noise in your area?

1	Yes	8.8
2	No	91.2

H9a. [H9=1] Can you tell me more about that?

H9b. Were you aware that activities at [NAME OF INSTALLATION] may create noise before you first moved to your current neighborhood?

1	Yes	65.6
2	No	32.0
8	Don't know	2.2
9	Refused	0.1

H10. To the best of your knowledge is your hearing normal?

1	Yes	82.5
2	No	17.4
8	Don't know	0.1

H11. [If H10=2] Do you use a hearing aid?

1	Yes	5.8
2	No	11.5
7	Not applicable	82.6

END1. One of my supervisors may contact you in the next week or so. It will only take a few minutes. The supervisor will want to make sure that all of your questions were addressed and that the interview was conducted properly.

ENDPHONE. What is the best telephone number where a supervisor could reach you? [INCLUDE AREA CODE]

ENDTIME. What is the best time of day for them to call? [IF NECESSARY: It would only take a few minutes.]

ENDNAME. And, what is your name?

END2. Thank you very much. We appreciate your help with this study.

H12. [INTERVIEWER]: Did the Respondent's hearing capacity seem to be:

Normal
Somewhat Diminished → DESCRIBE EXTENT OF PROBLEM BELOW
Severely Diminished → DESCRIBE EXTENT OF PROBLEM BELOW

H13. [If H12=2,3] Describe extent of hearing problem.
____

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14. ABSTRACT
Current blast noise assessment procedures at military installations in the United States do not fully meet the military's noise management needs; military blast noise sometimes disturbs surrounding communities, resulting in legal actions against US military installations. Specifically, current procedures do not accurately capture the way humans respond to blast events, and do not adequately account for the level, number, timing, and spatial variability of blast noise events. This work constructed and administered the General Community Survey (GCS) within SERDP Project WP-1546 at the first of three military installations to determine how blast noise levels affect general community annoyance and how the community reaction changes over time in response to a dynamic blast noise environment. The results indicate that, while blast noise was the most annoying noise source around this installation, current blast noise assessment metrics are weakly correlated with community annoyance, and a large percentage of the study population were highly annoyed at relatively low C-weighted Day-Night blast noise levels. Current findings highlight the importance of capturing temporal and spatial variation of the both stimulus and response, and also of non-acoustical factors such as habituation and vibration.

15. SUBJECT TERMS
SERDP, Human response, annoyance, blast, blast noise, impulse, noise management, military noise, military training, community survey, survey

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